DOCUMENTS EXPEDITING PROJECT

86th Congress
2d Session

COMMITTEE PRINT

RADIATION RESEARCH IN THE LIFE SCIENCES

CURRENT PROJECTS IN THE UNITED STATES AND THROUGHOUT THE WORLD

Information on the Magnitude, Organization, and Distribution of Programs

PREPARED FOR THE

COMMITTEE ON GOVERNMENT OPERATIONS
UNITED STATES SENATE

AND ITS

SUBCOMMITTEE ON REORGANIZATION AND INTERNATIONAL ORGANIZATIONS

(PURSUANT TO S. RES. 347, 85TH CONGRESS, AND S. RES. 42 AND 255, 86TH CONGRESS)

NOVEMBER 28, 1960

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LETTER OF TRANSMITTAL

U.S. SENATE,
November 28, 1960.

Hon. JOHN J. MCCLELLAN,
Chairman, Senate Committee on Government Operations,
Senate Office Building, Washington, D.C.

MY DEAR MR. CHAIRMAN: For the information of the subcommittee and of the Senate, there is submitted herewith a publication entitled "Radiation Research In The Life Sciences."

This is the 10th in a series of publications issued by this subcommittee as part of its international health study. The nine previous publications in the series are listed, together with our hearings, on the page which follows.

Each of these publications has been compiled by the staff at my request in cooperation with various authorities. Our purpose has been to fulfill the survey mission which the Senate conferred upon us. The original resolution which authorized the study was Senate Resolution 347, 85th Congress (as extended by S. Res. 42 and 255, 86th Cong.). Senate Resolution 347 provided for a complete study—

> * * * of any and all matters pertaining to international health research, rehabilitation and assistance programs * * * and * * * the coordination of programs related to international health.

Under rule XXV of the Standing Rules of the Senate, the Committee on Government Operations is entrusted with the responsibility of—

> Budgeting and accounting measures other than appropriations * * *
> Studying intergovernmental relationships * * * between the United States and international organizations of which the United States is a member.

The present publication describes activity in the field of radiation research on the part of 9 U.S. Government organizations and of 11 intergovernmental organizations of which the United States is a member.

The print consists basically of a report prepared, in accordance with our detailed request, by the U.S. Atomic Energy Commission. Its publication by the subcommittee is not intended to convey policy conclusions by the subcommittee itself; rather, it is intended to provide a factual framework for the subcommittee's further review.

Only in the final report, after the completion of the present series. will the subcommittee present its own conclusions.

With kindest wishes, I am,

Sincerely yours,

HUBERT H. HUMPHREY,
Chairman, Subcommittee on Reorganization
and International Organizations.

PUBLICATIONS ISSUED BY SUBCOMMITTEE IN INTERNATIONAL HEALTH STUDY

Committee Prints

Committee Print No. 1 (S. Rept. 160, 86th Cong.) was entitled "International Medical Research—A Compilation of Background Materials" (117 pp.). It set forth highlights of international research contributions in most of the major fields of disease, in addition to fulfilling other background purposes.

Committee Print No. 2 was entitled "Statutory Authority for Medical and Other Health-Related Research in the U.S. Government—The Basis for International Cooperation" (66 pp.). It contained the texts of the legal authority for medical research efforts by diverse agencies of the U.S. Government.

Committee Print No. 3 (S. Rept. 161, 86th Cong.) was entitled "The Status of World Health—In Outline Text and Chart" (81 pp.). Within it were presented charts on the incidence of certain major diseases throughout the world.

Committee Print No. 4 was entitled "The United States and the World Health Organization—Teamwork for Mankind's Well-Being" (145 pp.). It represented a personal report of the chairman of the subcommittee on the subject of WHO, based upon his conferences with the organization's officials and other authorities in Europe and on subsequent review.

Committee Print No. 5 (S. Rept. 1009, 86th Cong.) was entitled "Cancer—A Worldwide Menace, Some Facts and Figures on Its Incidence in the United States and Abroad" (40 pp.). It presented text and charts on the patterns of occurrence of malignant neoplasms in different countries of the world.

Committee Print No. 6 was entitled "Patterns of Incidence of Certain Diseases Throughout the World—Opportunities for Research Through Epidemiology" (50 pp.). It summarized epidemiological leads on important chronic and degenerative diseases in various nations. These leads, if followed carefully, may provide insight in the chain of discovery as to the cause and cure of maladies.

Committee Print No. 7 was entitled "The National Science Foundation and the Life Sciences" (96 pp.). It described domestic and international activities of the National Science Foundation and, principally, its work in the life sciences.

Committee Print No. 8 (S. Rept. 1038, 86th Cong.) was entitled "Rehabilitation of the Disabled in Thirty-Seven Countries of the World—Domestic Programs and International Activities in Technical Assistance" (153 pp.). It summarized activities in rehabilitation carried on in the United States and in other nations by official and nongovernmental organizations. The account of the official work abroad included assistance rendered by U.S. Government, foreign government and intergovernmental organizations.

Committee Print No. 9 was entitled "Health in the Americas and the Pan American Health Organization—Program of the Pan American Health Organization of the World Health Organization in the Americas" (105 pp.). It presented a summary of activities of this intergovernmental organization. This included its activity as regards communicable diseases, specific health problems, environmental sanitation, health services and facilities, coordination of research, health manpower as well as PAHO's possible future role.

Hearings

Hearings—Part I (310 pp.): Transcript of testimony by medical experts in Washington, D.C., in July 1959 and of discussions in Western Europe in October–November 1958 on long-range trends, opportunities and challenges in international medical research.

Note.—See page 19 for Table of Contents.

STATEMENT

By Hon. Hubert H. Humphrey, Chairman, Subcommittee on Reorganization and International Organizations

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This report summarizes:

(*a*) the magnitude
(*b*) the organization
(*c*) distribution

of worldwide efforts in radiation research in the life sciences.

It highlights man's current research endeavors to utilize and control the atom for beneficial purposes—protecting and healing man, providing more and better food for him.

The concern herein is not with the physical sciences and the production of energy for purposes of power, but with advancement of the sciences of living matter itself.

The report singles out current research projects, as such. It does so, because—

(*a*) these projects are at this very moment helping to open up new scientific horizons, and

(*b*) problems of maintaining and disseminating adequate information on on-going research are somewhat different from those which arise, once research has been completed and is the subject of technical documentation.

Comments in this statement of introduction cover three fields:

(1) The background and purposes of the study.
(2) The origin and procedures of the study.
(3) An introduction to the tentative findings.

1. Background of Study

This is the 10th in a series of studies initiated for purposes of comprehensive analysis of international problems of medical research.

A. Relationship with earlier prints

In the very first committee print entitled "International Medical Research," issued as part of the study, there was presented a summary of some of the great landmarks of radiation research.

In the second print, "Statutory Authority for Medical and Other Health-Related Research in the U.S. Government," the laws under which the Atomic Energy Commission functions were printed.

In the hearings conducted by the subcommittee, testimony was received from Prof. H. J. Muller, Nobel Laureate on radiation genetics and related problems (pt. 1, pp. 126 ff.).

In parts 2 and 3, the appendix volumes to the hearings, will be found numerous other comments related to radiation problems.

These are but a few of our presentations to date on this subject. Why we have done so is indicated in our legislative authority.

B. LEGISLATIVE AUTHORITY

This review was authorized under Senate Resolution 347, 85th Congress, which provided for a complete study—

> * * * of any and all matters pertaining to international health research, rehabilitation and assistance programs * * * and * * * the coordination of programs related to international health.

Under rule XXV of the Standing Rules of the Senate, the Committee on Government Operations is entrusted with the responsibility of—

> Budgeting and accounting measures other than appropriations * * *. Studying intergovernmental relationships * * * between the United States and international organizations of which the United States is a member.

In accordance with this authority, the fourth committee print in this series was devoted to the World Health Organization.

The present print refers to work of 11 intergovernmental organizations, particularly the International Atomic Energy Agency, concerned with radiation research.

Senate Resolution 347 was extended by Senate Resolution 42, 86th Congress. Subsequently, on April 11, 1960, the Senate approved Senate Resolution 255, 86th Congress. Section 4 of this resolution broadened the authority of the subcommittee, so as to conclude the international medical research study by January 31, 1961, and also to study additional problems and to report on them by that time.

Thus, this authority specifically enabled the subcommittee—

(*a*) to complete its study of worldwide health research, assistance, and rehabilitation matters; and

(*b*) to examine, investigate, and make a complete study of any and all matters in scientific and other fields where there may be indications of a need for (1) improved budgeting, accounting, and other managerial practices on the part of agencies of the U.S. Government; (2) strengthened cooperation and coordination among Federal agencies; (3) effectiveness of international organizations of which the United States is a member; and (4) avoidance of Federal duplication of private responsibilities and activities.

C. REASONS FOR REVIEW OF RADIATION RESEARCH

One of the phases which the subcommittee early singled out for its intensive review is the field of radiation research in the life sciences.

This research covers, by our definition, nine categories: radiation biology; radiation genetics; environmental radiation; radiation toxicology; radiation protection; agriculture; medical applications; radiation detection and measurement; education, training and information.

The reasons for our review of the work in these categories are several:

1. Decisions on radiation may involve the health of the American people and the entire human race.

2. Radiation research involves not 1 nor 2 but no less than 10 agencies of the U.S. Government and with rising financial and personnel commitments.

3. In few, if any other, fields of research in the life sciences does the Federal Government, as such, contribute a larger proportion of funds.

4. Radiation research is being carried out internationally with both U.S. and/or foreign support.

5. Radiation research involves, as previously noted, numerous intergovernmental organizations.

By these and other criteria, attention to this subject clearly falls within the legislative mandate which the Senate has three times conferred upon the subcommittee.

D. JURISDICTION OF JOINT COMMITTEE ON ATOMIC ENERGY

The subcommittee is, however, cognizant of the fact that jurisdiction for the field of atomic energy rests, under rules of the Senate, in the Joint Committee on Atomic Energy.

It is universally recognized that no group within the legislative branch is better qualified to appraise the contents of this or any other technical report in this field than is the Joint Committee. And no committee is in a position to take whatever action, if any is necessary, following up on this report, than is the Joint Committee. Accordingly, from the inception of this project, I have been in touch with the chairman of the Joint Committee, the Honorable Clinton P. Anderson. He responded graciously and with due reference to the jurisdiction and work of his colleagues and himself.

The completed report is now respectfully submitted to the Committee on Government Operations and to the Joint Committee on Atomic Energy.

E. SUBCOMMITTEE ON DISARMAMENT

Another committee with jurisdiction is the Committee on Foreign Relations and, in particular, its Subcommittee on Disarmament, of which I am privileged to serve as chairman.

The report is accordingly being submitted to other members of the Disarmament Subcommittee, as well, for such attention as they may feel it may require.

F. DEMARCATION OF THIS REPORT FROM OTHER COMMITTEES' REPORTS

Faithful to our own committee's obligation as regards economy and efficiency, every effort has of course been made to avoid any duplication of effort.

The entire report is, it should be noted, of a procedural, organizational, statistical nature, rather than of a substantive, technical nature.

The report asks and attempts to answer: "Who is doing what, where, and with what resources?" in radiation research, rather than attempting in any way to appraise the quality of the research, the priorities, the progress or other highly technical features.

The Committee on Government Operations has moreover sought to single out interagency phases of the radiation research problem. We are basically interested in what departments and agencies are doing in relationship with one another, rather than in their internal operations as such.

It is in the interagency and, especially, the civilian-type phases that the committee feels it may best be able to make a contribution, which

will supplement the many contributions already made by the Joint Committee.

The reader will find in past and current reports by the Joint Committee the most expert and complete documentation as related to the present report. The Nation and the world are, in my judgment, indebted to the Joint Committee, for the constant attention which it has given to biomedical areas of radiation work.

G. ILLUSTRATIONS OF SIGNIFICANCE OF RESEARCH

Since this is not a report on the substance of radiation research but on the procedures, organization, magnitude and coordination of research, it may be somewhat difficult for the layman to appreciate the full significance of the topic. A method by which we may more clearly express the meaningfulness of this presentation is by specific illustrations at this point.

The chart on the following page (fig. 1) is based upon one category—medical applications. It highlights the history of radiation treatment of the second worst killer in the United States and in the Western World—malignant neoplasms—which the layman recognizes by the name, cancer.

The successive stages in the development of X-ray treatment of cancer and in the use of natural and artificial radioactive isotopes have been tremendously accelerated in recent years. This is thanks to the type of research and development which is referred to in the pages which follow.

Two other approaches by which this subject may become more meaningful are by review of excerpts which now follow from two reports. Each of these reports is of a different character and had a different purpose. Together, the excerpts may serve to underline the intrinsic importance of this topic of radiation research.

H. RADIOISOTOPES IN MEDICINE

The first report to which we will briefly refer is once again (in keeping with the basic mandate to the subcommittee) in the field of medical applications. This particular report is entitled "Radioisotopes in Medicine." [1] The report documents the enormous role now being played by radioisotopes.

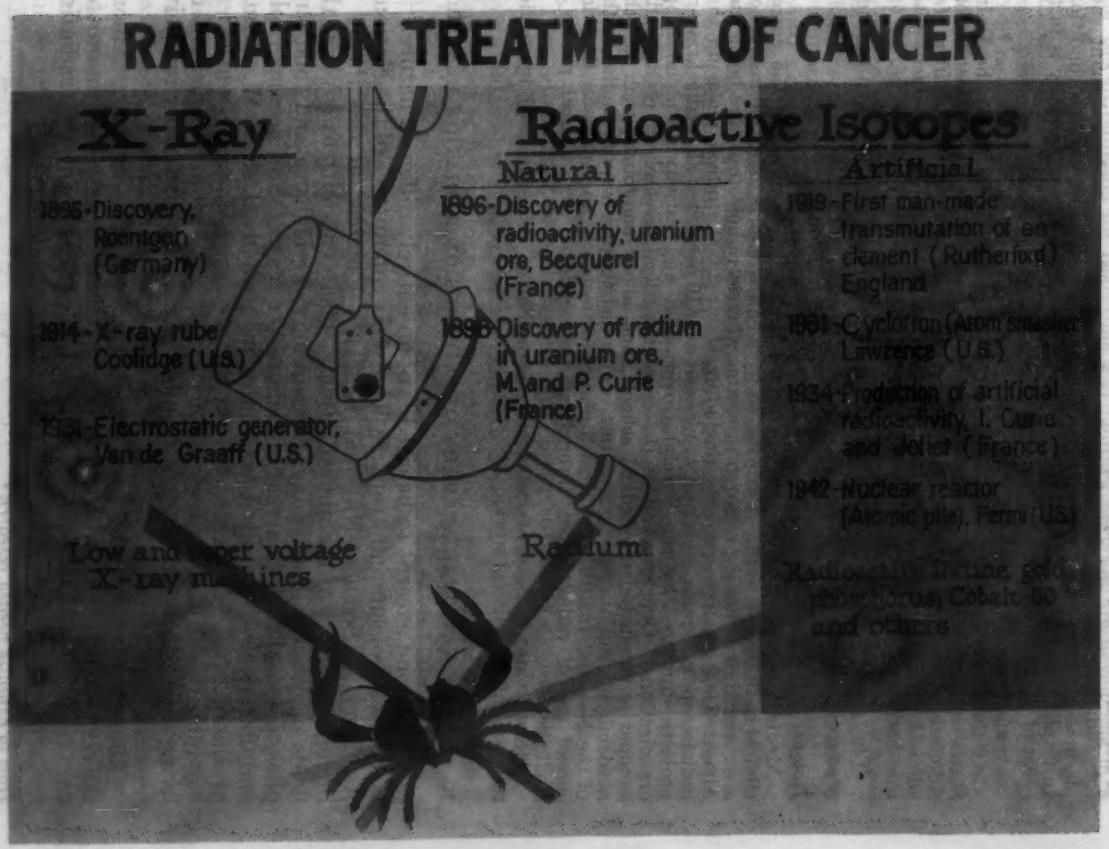
The report states, concerning the current volume of clinical applications:

> At the present time, an estimated 400,000 administrations of radiopharmaceuticals to humans are made annually. Well over 20 different nuclides are in relatively routine use for as many different procedures and purposes. Over 85 percent of all administrations are for diagnosis, the balance for therapy.

* * * * * * *

[1] Stanford Research Institute, "Radioisotopes in Medicine," prepared for Office of Isotope Development, U.S. Atomic Energy Commission, Washington, D.C., December 1959, pp. 6-9.

FIGURE 1


RADIATION TREATMENT OF CANCER
X-Ray
1895-Discovery, Roentgen (Germany)
1914-X-ray tube Coolidge (U.S.)
1931-Electrostatic generator, Van de Graaff (U.S.)
Low and upper voltage X-ray machines
Radioactive Isotopes
Natural
1896-Discovery of radioactivity, uranium ore, Becquerel (France)
1898-Discovery of radium in uranium ore, M. and P. Curie (France)
Radium
Artificial
1919-First man-made transmutation of an element (Rutherford) England
1931-Cyclotron (Atom smasher) Lawrence (U.S.)
1934-Production of artificial radioactivity, I. Curie and Joliot (France)
1942-Nuclear reactor (Atomic pile), Fermi (U.S.)
Radioactive iodine, gold, phosphorus, Cobalt 60 and others

Well over four-fifths of all administrations are performed in hospitals and clinics, the balance in private offices. On the average it appears that about three out of every thousand persons visiting clinics and admitted to hospitals undergo some type of diagnosis or therapy involving the use of radioisotopes. Of a number of selected hospitalized conditions, the volume of radioisotope administrations ranks along with such conditions as reduction of fractures, appendectomies, and repair of hernias. * * * The major chronic conditions that offer the most opportunity for radioisotope administration—glandular conditions and malignant neoplasms—are relatively less frequent than most of the other chronic conditions. In total, the number of persons experiencing these conditions annually is in the order of 2.5 million.

* * * * * * *

At the present time about 1,000 short-term general hospitals in the United States offer radioisotope services, concentrated mainly in larger institutions. Admissions to institutions with isotope services account for over two-fifths of all admissions to hospitals, which is double the amount of admissions in hospitals that had isotope service only 6 years ago.

The report then proceeds to outline the increasing usage in medical research, as such:

Isotopes in medical research

Medical research has, of course, formed the basis for much of the current clinical radioisotope work. Carrying on from earlier efforts, over 300 institutions are currently conducting research programs wherein radioisotopes are being used. Almost 2,000 separate projects (including about 2,600 studies) make up these radioisotope programs, which may represent over 10 percent of all medical research projects supported by the Federal Government and nationwide philanthropic organizations. Over one-half of the current medical research involving radioisotopes is conducted at medical schools, and about one-fourth each at other academic institutions and in hospitals. This distribution is quite similar to that of the National Institutes of Health grants for research, and indicates the widespread use of radioisotopes throughout the academic and clinical phases of medicine.

A far greater variety of radioisotopes—well over 100—are used in medical research than in clinical work.

I. VIEW OF NATIONAL ACADEMY OF SCIENCES ON RADIATION RESEARCH

The second excerpt to be cited is of an entirely different nature. It is from a set of summary reports filed by six committees of the National Academy of Sciences-National Research Council on the theme of biological effects of atomic radiation. These committees covered the fields of genetics, pathology, meteorology, agriculture and food supplies, disposal and dispersal of radioactive wastes, and oceanography and fisheries. Appointed originally in 1955 by Detlev W. Bronk, president of the National Academy of Sciences, they were asked to conduct a continuing appraisal of the effects of atomic radiations on living organisms and to identify questions on which further intensive research was urgently needed.

The committees filed reports which were published in 1956. Among the six supplementary reports recently filed was one by the Committee on Genetic Defects. In that report, the significance of radiation research was further documented, as follows:

How to expedite needed research[3]

Many of the investigations needed for the desired refinements of estimates of the genetic hazards to man of given levels of radiation are now underway in various academic institutions and in special research laboratories supported privately and by governments. No doubt appropriate additional financial and other encouragement would be effective in speeding up these efforts and in other-

[3] National Academy of Sciences-National Research Council: "The Biological Effects of Atomic Radiation—Summary Reports from a Study by the National Academy of Sciences." National Academy of Sciences-National Research Council, Washington, 1960, pp. 14-15.

wise making them more effective without requiring unrealistically large additions to present manpower at the higher level of scientific competence.

Government agencies such as the Atomic Energy Commission, the Public Health Service, and the National Science Foundation, as well as international agencies such as the World Health Organization and United Nations committees, are constantly reviewing their overall research programs. It is especially important that this be done in the area of radiation hazards, for the various large-scale uses of radiation for peacetime and military purposes are developing at a rapid rate.

In the specific area of genetic hazards—the special province of this committee—both Government and nongovernment laboratories and agencies in the United States and other nations should see to it that needed research is done well and as rapidly as feasible. No doubt in certain areas the research effort needs strengthening. In others in which there is now no activity, it may need encouragement.

How best to do this is a question on which both investigators and administrators have wide differences of opinion. Some would say that all that is necessary is to see that able investigators are adequately supported—that they will find the gaps in our present knowledge and devise ways of closing them. *Others would say that coordinating committees are needed to make systematic surveys of what needs to be done* and recommendations as to how to get it done. [*Italic supplied.*]

Perhaps no one approach can provide a complete solution. No doubt both Government and private agencies will continue to use staffs of professionally trained geneticists and to appoint advisory committees and study panels to assist them. The Federal Council of Science and Technology may well choose to sponsor a review of the present total effort in the radiation hazards field.

Whatever the approach, it is most important that able investigators with creative ideas be identified, be given adequate facilities, be provided stimulating environments for their work, and be given reasonable assurance of continued support. If this is done well, many of the problems that would otherwise go unsolved will be taken care of with competence and dispatch.

J. THE SUBCOMMITTEE'S WORKING PREMISE

This subcommittee points out that if one of these eventualities is to come to pass, i.e., if "coordinating committees" are to make "systematic surveys" of what needs to be done, they must first determine what is being done. In order to determine what is being done, it might reasonably be presumed that they might first seek to ascertain:

(*a*) what is the state of the art, i.e., what is the substantive knowledge in each given field on the basis of past research;

(*b*) what work is actually underway to advance the state of the art.

Both types of knowledge are essential in order to plan research for the future. It would appear that scientists can hardly make the soundest recommendations as to where future research might be directed to bridge gaps if they are not currently apprised of what research is now being conducted. Conversely, it would appear hardly sufficient to make such recommendations if one only knows what research is now under way without simultaneously knowing the intrinsic significance of the research in terms of the present state of the art. This twofold view is the working premise on which the subcommittee has made this review.

Among numerous other objectives, it has sought to determine an answer to the procedural question:

Do Federal granting organizations know who is doing what, where and with what resources, and if so how do they know it?

K. PROBLEMS OF COORDINATION OF RESEARCH KNOWLEDGE

As earlier indicated, a major interest of the subcommittee is in the field of coordination. We are interested in coordination problems—

(1) between Government agencies;

(2) between Government agencies and private research sources—foreign and domestic;

(3) between the U.S. Government and foreign governments;

(4) between the various governments and intergovernmental organizations;

(5) among intergovernmental organizations.

The subcommittee seeks, in effect, answers to the question: "What is the extent of coordination of knowledge as to current research within, among and between all of the respective groups mentioned above?"

L. NEW "BASELINE" OF MAGNITUDE

This objective, as important as it is, from our own specialized view, might not have been enough to merit the huge volume of work which compilation of the report required, at home and abroad, on the part of both American and foreign nationals.

A primary goal, therefore, was the preparation of a needed "baseline"—one heretofore not available anywhere in the world—on the overall magnitude and organization throughout the nations of current radiation research in the life sciences. We regard this baseline, and we believe others may also regard it, as a helpful contribution to the field.

M. SEPARATE BUDGET-TYPE PRESENTATION

This is not the only reference by the subcommittee to the field of radiation research. A separate presentation of health-related expenditures by diverse Federal agencies will be set forth in detail in a forthcoming committee report. Therein will be found the relevant budgets of the Atomic Energy Commission and other Federal agencies.

For example, in the 1960 fiscal year, it is tentatively estimated that the AEC may obligate $89.9 million for medical and other health-related programs, including $48.4 million for medical and other health-related *research*.

It is further estimated in that print that, as of June 1958, AEC and contractor personnel numbered:

(*a*) 3,500 scientists and 3,524 support personnel engaged in whole or in part in medical and other health-related programs, including

(*b*) 2,408 scientists and 2,711 support personnel for medical and other health-related *research*.

N. CLEARINGHOUSE ON RADIATION AND OTHER RESEARCH

Still another procedural-type reference by the subcommittee to radiation research will be in the form of our future detailed findings on the Bio-Sciences Information Exchange (which has just been reconstituted as the Science Information Exchange). This is a Federal clearinghouse of research information, which is supported by seven Federal agencies, including the AEC. It should be noted

that the subcommittee contacted the exchange in order to ascertain the magnitude of radiation research projects. The response by the exchange provides a basis for certain observations which are made in part 5 of this print. These observations provide a form of preview to more complete views which will be presented in the final report with regard to the role of a clearinghouse in U.S. Government biomedical research.

Again, this type of review illustrates the focus of our approach—on interagency problems—the type which falls most properly within our standing jurisdiction.

2. Origin and Procedures of the Study

The print has been developed in a manner similar to that which has been used, we believe, effectively in our other prints:

(*a*) preliminary identification of the problem;
(*b*) consultation with Federal agency and other experts;
(*c*) preparation of a working outline to meet the problem;
(*d*) review of the outline;
(*e*) designation of a Federal agency to serve as a central source of assistance to the subcommittee in carrying out the project, pursuant to the outline.

In this instance, the U.S. Atomic Energy Commission was asked to undertake primary responsibility for compiling the report. The Commission agreed to do so. It assigned a staff member in the Division of Biology and Medicine, Dr. Walter D. Claus, as editor to compile and correlate the various efforts of many agencies and organizations.

A. Exchange of Correspondence

The work was initiated as a result of a request which I conveyed to the Atomic Energy Commission on May 21, 1959.

My letter of request follows:

May 21, 1959.

Hon. John A. McCone,
Chairman, U.S. Atomic Energy Commission,
Washington, D.C.

My Dear Mr. Chairman: Yesterday, on the Senate floor, in commenting on the "International Health Study" being made by this subcommittee, I expressed appreciation for the cooperation which has been extended to us by yourself and by other Federal agencies (p. 7740, May 20 Congressional Record).

I should like now to confirm the arrangements which have been initially explored by the project director of our study, Mr. Julius N. Cahn, with the Director of your Division of Biology and Medicine, Dr. Charles Dunham, relative to a proposed publication which this subcommittee may issue under the theme: "National and International Cooperation in Radiation Research."

I invite your attention to the text of an address which I delivered on May 9, just after our meeting together. As you will note on page 7709 in the [same] record, I urge in that address strengthened programs for radiation research and for coordination among the various national and international agencies concerned. I pointed out the significant coordination already under way on the part of the Division of Biology and Medicine with other Federal units.

Now, insofar as our future subcommittee publication is concerned, Mr. Cahn will be taking up with Dr. Dunham a proposed outline on which we will appreciate your staff's judgment and assistance thereafter in following through in compiling the varied data which will be needed.

In the meanwhile, I am enclosing a half dozen copies of a committee print (which we are releasing this Sunday) consisting of my report on WHO.

As you will note, here, too, (pp. 8, 81, 103, 104) I have stressed the importance of intensified and coordinated radiation research.

With kindest regards, I am

Sincerely,

HUBERT H. HUMPHREY, *Subcommittee Chairman.*

Chairman McCone responded as follows:

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., June 9, 1959.

DEAR SENATOR HUMPHREY: Thank you for your letter of May 21, calling my attention to your important address before the Second National Conference on World Health. I heartily agree with the highlighting you gave to the importance of radiation research and the necessity for its national and international coordination.

I am very pleased that our Division of Biology and Medicine can be of help to your subcommittee in the compilation of data for your study. As you know, Mr. Cahn of your staff and Dr. Dunham, Director of the Commission's Division of Biology and Medicine, have already had informal discussions along this line. We are anxious to cooperate fully, and you can be sure that we will give this matter the highest priority here.

* * * * * * *

Sincerely yours,

JOHN A. MCCONE.

The first task undertaken was to define carefully the material that would be most useful, and to draw up a revised outline. The final draft of the outline is printed as exhibit A, page 147 ff.

B. REQUEST FOR COOPERATION FROM OTHER SOURCES

As chairman of the Subcommittee on Reorganization and International Organizations, I then directed a copy of the outline of desired information, together with an invitation to participate in its preparation, to the heads of all U.S. agencies which were thought to be conducting or supporting radiation research in the life sciences. In every case the invitation was graciously acknowledged with assurances of cooperation, and a staff member was assigned responsibility for assembling the data within his own agency. The reports were forwarded to the AEC for preparation for publication.

Insofar as possible, the plan of compilation, and invitations to participate, were extended to foreign governments and international organizations through AEC technical representatives abroad—in Brussels, Buenos Aires, Chalk River (Canada), London, Paris, and Tokyo.

The U.S. Department of State undertook further contacts through its missions to the United Nations and to the International Atomic Energy Agency, through its consulate general in Geneva, and through its Embassies in Paris, Rome, Bonn, Copenhagen, Oslo, Stockholm, Brussels, and New Delhi.

Contacts with the Organization of American States were made directly by the AEC.

C. OUTLINE REVISED AS WORK PROGRESSED

The outline primarily represented the subcommittee's wishes. Dr. Claus and his associates in the Commission accommodated to the subcommittee's information needs. In each phase of the project, however, as we jointly anticipated, the AEC and cooperating offices

found it necessary to adapt certain parts of the outline in accordance with the experience of attempting to assemble the requested data.

The reader will find that the completed print by no means contains all of the information envisioned in our original outline, nor is it complete even as regards those aspects which are "covered."

The Atomic Energy Commission in officially transmitting the contents to the subcommittee pointed out the various gaps.

D. MINIMAL EDITORIAL COMMENT WITHIN TEXT

As might be expected, material received by the AEC from cooperating sources came in many different forms and degrees of completeness. Insofar as possible, these materials were prepared for this publication with a minimum of editing, although condensation was generally necessary. In some cases, the versions presented here were prepared as digests of detailed data and reports submitted by the several countries. The editor has expressed the hope that these digests present a reasonably accurate picture of the large amount of important research which is progressing in these countries.

The final manuscript was received by the subcommittee in April 1960. The results, parts 1–4, speak for themselves.

E. APPRECIATION

The subcommittee expresses appreciation to Chairman John W. McCone for the Commission's cooperation and to Dr. Walter D. Claus for his carrying out a difficult, but we believe, and hope, fruitful assignment in collaboration with our project director.

We are grateful as well to the many governments, organizations, and individuals whose helpfulness made it possible to develop what we trust will serve as a useful "benchmark" for the future.

The subcommittee feels a deeper admiration than ever before for the dedicated men of science, whose work is referred to, if only in general terms, herein. It is thanks to their efforts that we hope and believe that the years to come will witness further blessings to mankind from "Atoms for Health."

3. Introduction to the Tentative Findings

In part 5, page 135 ff, I have respectfully submitted a personal summary of tentative findings as regards the report. This summary should not be construed as a subcommittee statement of policy. Only in the final report after additional related committee prints have been completed will the subcommittee, as a unit, express its formal judgment. Several of my colleagues have already indicated, however, that they do share the judgment which I submit.

It will be noted that my findings are of a twofold nature. They are on—

(*a*) the magnitude and organizational framework of international radiation research;

(*b*) problems of information—management and coordination on the research.

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All of the evidence for the findings on category (*a*), magnitude and framework, derives from the helpful report compiled by the Atomic Energy Commission.

By contrast, findings on (*b*) are based only in part on information from the Commission.

These findings in category (*b*) derive from the subcommittee's voluminous correspondence and contacts on procedural problems with a multiplicity of U.S. and foreign agencies, with the Bio-Sciences Information Exchange (as it has heretofore been known) and other organizations. This latter evidence will be presented in great detail in a future publication of the subcommittee, as stated on page 11. The present report provides, in effect, an illustration for one field—of certain problems in information-management which exist, in our view, in virtually all fields of biomedical knowledge.

Regrettably, because of numerous factors, it has not and may not be possible for our subcommittee to hold hearings on this particular subject of radiation information (aside from a very brief phase on an occasion referred to on p. 146). Among the reasons detailed hearings by the subcommittee are not possible are: (1) Radiation research is but one of well over a dozen separate topics being studied by the subcommittee; (2) as it states elsewhere in this report, the subcommittee does not presume itself competent to make substantive appraisals of the technical aspects of the subject; the Joint Committee on Atomic Energy is the expert group in the Congress to do so.

The subcommittee believes that the Joint Committee can follow through, as it may see fit, on this report, with hearings or other study, to the extent it may deem appropriate.

As to findings on the contents herein, the subcommittee necessarily has had to rely to a large part upon the evaluations made by its project director. He, in turn, has pointed out very clearly the above and related limiting factors.

Despite these limitations which the subcommittee carefully and clearly specifies, the tentative findings of a procedural nature which I, as chairman, submit in part 5, are based upon carefully compiled, albeit limited evidence. These findings merit the earnest judgment of the Atomic Energy Commission and other Federal agencies.

PREFACE

1. Contents

In the letter of request to each agency, the draft outline which was enclosed indicated contents, as follows:

Each agency was asked to assemble specified data on the magnitude and organization of research—both basic and applied—which is being conducted to explore the beneficial and harmful effects of radiation on the biosphere.

Clinical research and training in biomedical phases of radiation were to be included, where the term "clinical research" referred to the diagnostic and therapeutic use of radioisotopes and teletherapy units, and of radiation from accelerators (cyclotrons, betatrons, linear accelerators, etc.), reactors and various types of critical assemblies. It did not refer to clinical research with conventional X-ray units, except that in some cases if the device and its application seemed unique, the study might be included. Also included would be studies of the incidental effects of X-ray treatments such as genetic, leukemic, etc. Statistical and budgetary information was requested. Excluded would be programs and projects primarily of industrial and military character.

2. Definitions

Each supporting agency and organization was asked to present its program from the point of view of what, who, when, why, and with what significance? These are explained as follows:

What? Research programs were defined in terms of the nine categories described below. No attempt was made to distinguish between basic and applied research, but consideration was directed to the term "radiation research." It was not desired to prepare a general compendium of all the biological research going on in the world which uses radioisotopes simply as a tool or tracer. The purpose of the compendium was to explore the beneficial and harmful effects of radiation on living systems and on molecular systems important to life. Hence if the purpose of a piece of research is to help elucidate these effects, whether the research uses radiation directly or consists simply of a study of normal processes, it was desired that it be included in the compendium. The nine categories of research and training were defined as follows, and all projects were to be arbitrarily classified under these nine categories.

DEFINITIONS OF NINE CATEGORIES

(1) *Radiation biology.* Studies on somatic effects of exposure to radiation from sources external to the organism or other target material; normal physiological processes and responses where these must be studied further to provide background information for understand-

ing the perturbations caused by radiation; developmental aberrations; psychological and performance effects. Molecular and cellular systems, tissues, organs, and whole organisms are included in this category.

(2) *Radiation genetics.* Studies of the effects of radiation on the genetic constitution of single cells, plants, animals and human beings, gene mutations and mutation rates; chromosome aberrations, populations genetics; chemistry of genetic units as it relates to the genetic process. Experiments designed primarily to improve crops or livestock should not be included in this category, but under "Agriculture."

(3) *Environmental radiation.* Studies of the environmental situation including background radiation, meteorology, oceanography and marine sciences; ecological and epidemiological responses to the environment; demographic and public health statistics; fallout and environmental contamination, but excluding studies made primarily to facilitate weapons testing.

(4) *Radiation toxicology.* Studies of the metabolism and toxic effects of radioisotopes (both natural and manmade) to which man and animals are exposed.

(5) *Radiation protection.* Studies of procedures for combating radiation effects, including biological and medical treatments; waste management, shielding against radiation, health physics methods; pure physics which is conducted for its ultimate application to problems of radiation control.

(6) *Agriculture.* Studies on agriculture insofar as crops and farm animals may be improved by the use of isotopes or radiation, or as they must cope with increasing radiation in the environment; plant and animal physiology as related to radiobiological studies; food sterilization.

(7) *Medical applications.* Studies on the genesis and diagnosis of cancer and leukemia, insofar as these studies utilize radioisotopes and radiation; diagnosis and treatment of disease with radioisotopes and teletherapy.

(8) *Radiation detection and measurement.* Studies on the development of instruments and methods for the detection and measurement of radiation and radioisotopes, including whole-body counters and bio-assay procedures.

(9) *Education, training, and information.* Programs devoted specifically to increasing technical competence and public knowledge in the area of radiation effects in the life sciences; consultative and advisory functions, special committees, etc.

Tabular summaries.[1]—U.S. agencies and foreign and international organizations were asked to fill in appropriate entries, insofar as possible, in two tables—(A) on "Budgetary and manpower data," and (B) on "Organizational data" with references to descriptive paragraphs.

Data for table A.—For each of the nine categories, data were requested for inclusion in table A on—

1. The number of separate projects (that is, organized projects as distinguished from subdivisions and individual experiments);
2. Funds obligated for the most recent fiscal year (fiscal year 1959 for U.S. agencies);

[1] Tabular summaries, as tables A and B, for U.S. agencies are contained in the sections following.

3. Number of scientific man-years devoted to the activity in the most recent fiscal year. (A scientific man-year is defined for this purpose as the full-time assignment of a research employee who has the B.S. degree, its equivalent or better, and who is directly engaged in or is directly supervising the activity, as distinguished from a technician whose work is entirely under the direction of a scientist);

4. Approximate number of supporting man-years of effort for the most recent fiscal year, insofar as such information may be available (i.e. "supporting" effort may include technical, diener, secretarial and administrative man-years directly related to the project).

Data for table B.—Descriptive paragraphs on who, where, when, why and relationships were requested, to be specifically keyed into table B on "Organizational data" as indicated below:

Who? What division in the organization is sponsoring the research, to whom does it report, and what is its part in the total organization?

Where? A brief, general description of the physical facilities devoted to the research, in terms, possibly, of location; unique characteristics, if any of the laboratory facilities, special equipment, personnel, etc. Where the research is carried on through contracts with a number of universities or institutes, it would be sufficient to state simply that the work is done in so many university or institute laboratories. Where the research is done in only a few such laboratories, these were to be identified together with any special features about them.

When? Is the program conducted on a regular basis, or on an irregular or ad hoc basis? In either case, when was it begun, and are there plans for altering, increasing or terminating the direction of the effort?

Why? What is the significance of the effort in the overall mission of the supporting agency or organization in terms of its own statutory requirements?

With what relationships to other organizations? What are the relationships of each agency's research efforts to the efforts of other agencies and organizations; note how the various efforts may complement and supplement one another, how gross duplications are avoided, and how the research results are disseminated and made available to policymaking authorities. Brief summary information was desired on interagency relationships and intergroup working committees, with special emphasis on worldwide organizations and interrelationships. How, for example, does research information developed in one place find its way into worldwide application (through other than standard reporting in scientific journals etc.)?

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*NOTE.—The series of identifying letters is, as will be noted, listed in sequence. The reason is indicated on p. 27 wherein the code-numbering system from a to zz in the print, corresponding to the master tables, is explained.

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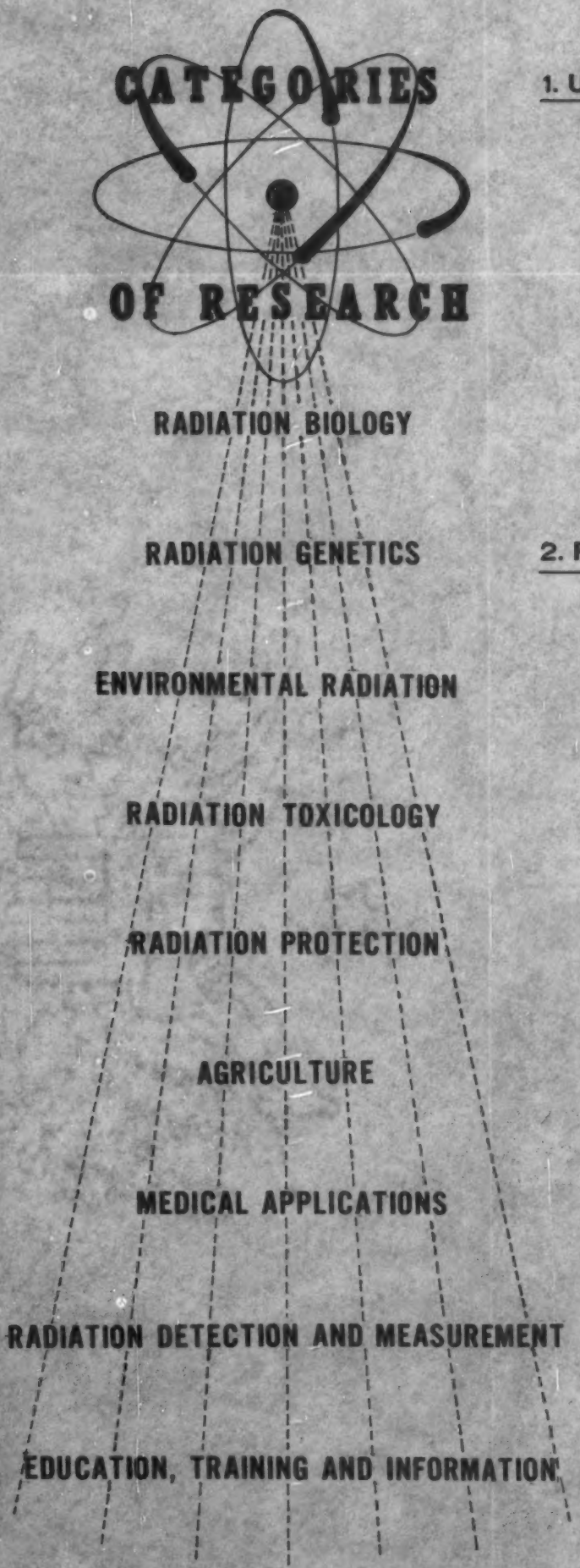
SUMMARY OF UNITED STATES AND FOREIGN SOURC
IN THE LIFE SCIENCES AND OF THEIR P

TOTAL NO. OF PROJECTS – 3,362 (Estim
TOTAL EXPENDITURES – $ 101 – 111 M



—— SOURCE ——

1. UNITED STATES -

A. FEDERAL AGENCIES WITH
(In order of volume of fu
Atomic Energy Commission -
Department of Health, Education
Department of Defense -
Veterans Administration -
Office of Civil and Defense Mobil
Department of Commerce - Natio
National Science Foundation -
Department of Interior -
Department of Agriculture -
(National Academy of Sciences - N
(included within Atomic En

B. NON-OFFICIAL - SIXTEEN (1

Voluntary Health Agencies and F

2. FOREIGN AND INTERNATION

A. FOREIGN NATIONS (Other th
With Known Research Exp
Japan
United Kingdom
Canada (Includes amounts spent
privately controlled canc
Sweden
Germany
Denmark
Argentina
France
Italy

B. ADDITIONAL NATIONS IN T
ATOMIC ENERGY PROGRAMS
EXPENDITURES ARE NOT

- Brazil
- Chile
- Colombia
- Costa Rica
- Cuba
- ElSalv
- Norwa
- Peru

C. UNION OF SOVIET SOCIALI
In Addition to Nations Within th

D. INTER-GOVERNMENTAL OR
RESEARCH EXPENDITURES
International Atomic Energy Age

E. OTHER INTER-GOVERNMEN
WITH INTERESTS IN THIS

Food and Agriculture Organizati
International Labor Organisation
Scientific Committee on Effects
World Health Organization
World Meteorological Organizati
United Nations Education, Scient
Organization of American State
Pan-American Health Organizat
European Organization for Nucl
European Atomic Energy Comm
Organization for European Econ

N SOURCES ENGAGED IN RADIATION RESEARCH
THEIR PROJECTS AND OUTLAY

362 (Estimated)
I — 111 MILLION (Est'd. & Rounded)

OURCE —	NO. OF PROJECTS	DOLLAR VOLUME OF PROJECTS (Figures rounded out)
	2,036	63,425,000
ES WITH RESEARCH EXPENDITURES..... (volume of funds expended)	1,986	62,885,000
mission -	1,027	47,486,000
n, Education and Welfare -	392	6,299,000
se -	140	5,024,000
tion -	232	1,035,000
Defense Mobilization	10	1,202,000
nerce - National Bureau of Standards	97	594,000
ndation -	37	476,000
or -	38	454,000
ulture -	73	315,000
f Sciences - National Research Council) n Atomic Energy Commission)	(33)	($ 1,926,000)
IXTEEN (16) GRANTING ORGANIZATIONS		
gencies and Private Foundations	50	540,000
NATIONAL -	1,326 (Est.)	$ 38,000,000 - 48,000,000 (Est.)
(Other than U.S.S.R.)	942	7,667,000 (Est.)
search Expenditures.	180	2,400,000
	325	2,000,000 (Est.)
nounts spent by two ontrolled cancer funds)	82	1,272,000
	112	950,000
	60	690,000
	-	225,000
	11	130,000
	130	-
	42	--
IONS IN THE FREE WORLD WITH PROGRAMS WHOSE RESEARCH RE NOT KNOWN		
• Cuba • Uruguay • ElSalvador • Venezuela • Norway • Peru	Not Available	
T SOCIALIST REPUBLICS	336	$30,000,000 - 40,000,000 (Est.)
ons Within the Soviet Bloc.	Not Available	
NTAL ORGANIZATION WITH DITURES		
c Energy Agency	48	309,000

VERNMENTAL ORGANIZATIONS
IN THIS FIELD.

re Organization
Organization
ee on Effects of Atomic Radiation
nization
al Organization
cation, Scientific and Cultural Organization
erican States
lth Organization
ion for Nuclear Research
nergy Community
ropean Economic Cooperation

International Health Study
Subcommittee on Reorganization and International Organizations
Committee on Government Operations,
U.S. Senate October 1960

58366 O - 60 (Face p. 23)

SUMMARY

Available data follows as regards the current commitment by the nations of the world in—

(*a*) radiation projects in the life sciences;
(*b*) dollar volume represented within these projects;
(*c*) numbers of scientific and
(*d*) supporting personnel engaged in these projects.

Items (*a*) and (*b*) above are depicted in the chart which faces this page, while (*a*) through (*d*) are shown in the table at this point.

SUMMARY ON CURRENT RADIATION PROJECTS IN THE LIFE SCIENCES

Total number of projects, 3,362 (estimated)

Total expenditures, $101 to $111 million (estimated and rounded)

[Dollars in thousands]

Source of support	Number of projects	Funds	Personnel	
			Scientific	Supporting
1. United States	2,036	$63,425,000		
A. Federal agencies with research expenditures (in order of volume of funds expended)	1,986	62,885,000	3,007	3,296
Atomic Energy Commission	1,027	47,486,000	2,085	2,389
Department of Health, Education, and Welfare	392	6,290,000	405	444
Department of Defense	140	5,024,000	253	219
Office of Civil and Defense Mobilization	10	1,202,000	33	20
Veterans' Administration	232	1,035,000	95	141
Department of Commerce, National Bureau of Standards	37	594,000	55	32
National Science Foundation	37	476,000	6	8
Department of the Interior	38	454,000	64	32
Department of Agriculture	73	315,000	11	11
(National Academy of Sciences-National Research Council) (included within AEC)	(33)	(1,926,000)	(76)	(544)
B. Nonofficial, 16 granting organizations (voluntary health agencies and private foundations)	50	540,000		
2. Foreign and international	[1] 1,214	[1] 38,000,000–48,000,000		
A. Foreign nations (other than U.S.S.R.) with known research expenditures	942	7,667,000	367	405
Japan	180	2,400,000		
United Kingdom	325	[1] 2,000,000		
Canada (includes amounts spent by 2 privately controlled cancer funds)	82	1,272,000	71	
Sweden	112	950,000		
Germany	60	690,000		
Denmark		225,000	20	33
Argentina	11	130,000	20	35
France	130		188	227
Italy	42			
B. Additional nations in the free world with atomic energy programs whose research expenditures are not known [2]	(3)	(3)	(3)	(3)
C. Union of Soviet Socialist Republics	336	[1] 30,000,000–40,000,000	1,574	
In addition to nations within the Soviet bloc	(3)	(3)	(3)	(3)
D. Intergovernmental organizations with research expenditures: International Atomic Energy Agency	48	300,000	73	77

[1] Estimate.
[2] Brazil, Chile, Colombia, Costa Rica, Cuba, El Salvador, Norway, Peru, Uruguay, and Venezuela.
[3] Not available.

Part 1

ACTIVITIES OF AGENCIES OF UNITED STATES GOVERNMENT

A. U.S. Atomic Energy Commission

The U.S. Atomic Energy Commission was established by Congress through the Atomic Energy Act of 1946 which, with amendments—

directed [the AEC] to exercise its powers in such manner as to insure the continued conduct of research and development and training activities * * * by private or public institutions or persons and to assist in the acquisition of an ever-expanding fund of theoretical and practical knowledge * * *. To this end, the Commission is authorized and directed to make arrangements (including contracts, agreements, and loans) for the conduct of research and development activities relating to [among other items]—

utilization of special nuclear material and radioactive material for medical, biological, agricultural, health or military purposes;

the protection of health and the promotion of safety during research and production activities.

By Public Law 1006 (84th Cong.)—

the Commission is further authorized to make grants and contributions to the cost of * * * equipment to colleges, universities, hospitals and eleemosynary or charitable institutions for the conduct of educational and training activities related to the fields [above].

TABLE A.—U.S. ATOMIC ENERGY COMMISSION

BUDGETARY AND MAN-POWER DATA

(Fiscal year 1959, obligated) [1]

[Dollars in thousands]

Category [2]	Principal onsite facilities (d)				Secondary onsite facilities (e)				U.S. offsite facilities (f) Foreign offsite facilities (g)				Total			
	Number of projects	Funds	Man-years		Number of projects	Funds	Man-years		Number of projects	Funds	Man-years		Number of projects	Funds	Man-years	
			Scientific	Supporting			Scientific	Supporting			Scientific	Supporting			Scientific	Supporting
1. Radiation biology	79	$8,427.2	270	229	44	$2,787.5	104	189	238	$4,311.1	380	325	362	$15,530.3	756	743
									*1	4.2	2					
2. Radiation genetics	12	1,588.3	52	44	4	198.3	16	79	55	1,143.0	101	89	72	2,949.6	172	212
									*1	20.0	3					
3. Environmental radiation	3	551.4	16	3	25	2,052.3	88	32	88	3,711.5	231	240	121	6,353.1	340	275
									*5	37.9	5					
4. Radiation toxicology	8	1,488.3	40	29	19	1,349.8	34	20	36	1,664.5	103	136	63	4,502.6	177	185
5. Radiation protection	18	1,491.1	47	46	15	903.2	32	63	36	585.3	42	31	69	2,979.6	121	140
6. Agriculture					3	395.8	19	9	54	637.6	48	52	59	1,154.0	81	61
									*2	120.6	14					
7. Medical applications	8	973.9	24	22	41	3,599.9	90	354	39	1,051.1	59	72	89	5,644.9	183	448
									*1	20.0	1					
8. Radiation detection and measurement	13	1,281.4	40	28	21	1,226.9	34	30	23	1,125.4	61	117	57	3,633.7	135	175
9. Education, training and information													[3] 116	2,316.4		
													[4] 19	1,413.4		
10. AEC direction and research administration														1,008.0	120	150
Total	141	15,801.6	489	401	172	12,513.7	426	776	569	14,229.8	1,025	1,062	1,027	47,485.6	2,085	2,389
									*10	202.7	25					

[1] Fiscal year 1959 obligated funds in thousands of dollars. Scientific and Supporting Man-Years (see definitions, page 15).

[2] Also see table A for each of the U.S. agencies in the sections that follow.

[3] Division of Biology & Medicine.

[4] Division of International Affairs.

* Foreign.

TABLE B.—ORGANIZATIONAL DATA*

Research category [1]	Special comment	Who	Where	When	Why	Relationships
1. Radiation biology	l	a	d, e, f, g	s	t	t.
2. Radiation genetics	j	a	d, e, f, g	s	j	t.
3. Environmental radiation	k	a, b	d, e, f, g	s	k	u.
4. Radiation toxicology	l	a	d, e, f	s	l	v.
5. Radiation protection	m	a, b	d, e, f, h	s	m	w.
6. Agriculture	n	a	e, f, g, h	s	n	x.
7. Medical applications	o	a	d, e, f, g	s	o	y.
8. Radiation detection and measurement.	p	a	d, e, f, h	s	p	z.
9. Education, training and information.	q	a, c	d, f	s	q, r	r, zz.
10. AEC direction and administration.		a, b, c		s		

[1] Also see table B for each of the U.S. agencies in the sections that follow.

*NOTE.—The code letters correspond to the lettered paragraphs which follow.

1. WHO ADMINISTERS THE PROGRAM

a. *The Division of Biology and Medicine* has five research branches (medical, biology, environmental sciences, radiation instruments and fallout studies) which support research at AEC facilities and through direct contracts with public and private institutions, to provide leadership in the biomedical sciences for the exploration of all uses of nuclear energy. Specific objectives of the research program are: (1) to exploit the use of nuclear radiations and radioactive materials in studies of basic biological processes; (2) to increase knowledge of the biological effects of radiation for the purpose of understanding the mechanisms by which damage is produced and of developing radiation protection standards; (3) to obtain information and develop instrumentation useful in the control of biological hazards of radiation; (4) to develop information of a toxicological nature on those chemicals unique to the atomic energy program; (5) to improve and develop techniques for the use of radiations in medical diagnosis and therapy; (6) to develop and encourage the use of radiations in agricultural research. To these ends, the Division sponsors basic and applied research in radiation biology and medicine, and in instrumentation for radiation measurement and dosimetry. An *Education and Training Unit* sponsors special education and training activities including special fellowships in radiation health, high school and college faculty training in radiobiology, and grants of radiation equipment for encouraging college training in radiobiology. The Division obtains guidance from an *Advisory Committee on Biology and Medicine* which counsels the AEC on the formulation and direction of its medical and biological research and training programs.

b. *The Division of Reactor Development* has an *Environmental and Sanitary Engineering Branch* which plans and directs a comprehensive program related to the environmental and sanitary engineering aspects of nuclear energy operations, including research and development activities pertinent to the control of radioactive effluents. It develops and maintains a close working relationship with other Federal and State agencies in connection with the management of radioactive wastes and the environmental aspects of nuclear technology.

c. *The Division of International Affairs* has an *Office of the Assistant Director for Technical Implementation* which directs and administers

a program involving equipment grants, scientific information and personnel exchanges with foreign nations. It develops and coordinates U.S. training programs for foreign scientists and technicians, and gives support to international scientific meetings, conferences and missions.

2. WHERE THE WORK IS DONE

d. *The principal onsite laboratories of the AEC*, for the purposes of this report, consist of the Government-owned facilities of *Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Radiation Laboratory, Los Alamos Scientific Laboratory*, and *Oak Ridge National Laboratory*. A small program of the *Knolls Atomic Power Laboratory* (Schenectady, N.Y.) is included in this group.

1. *Argonne National Laboratory* (Lemont, Ill.): The Argonne program originated in 1942 as part of the Metallurgical Laboratory at the University of Chicago under the wartime Manhattan Engineer District. The laboratory dates officially from July 1, 1946. The biological and medical research program at the Argonne National Laboratory studies primarily the health hazards of acute and chronic exposure to external radiation and to internally deposited radioisotopes, for the dual purpose of providing a basis for permissible exposure to radioactive materials and for understanding damage caused by radiation so as to prevent damage or treat resultant illness. A major program expansion is currently underway on long-term biological effects of low-level radiation. A detailed epidemiological program to study persons ingesting higher than average levels of radium in drinking water is being expanded. These studies are integrated with the continuing followup of radium dial painters and other persons known to be carrying significant body burdens of radium. A whole-body counter facilitates studies of chronic effects of low-level radiation exposures. A comprehensive program on the biological effects of fission neutrons from very low to extremely high dose rates will be initiated upon completion of a special biological research reactor in 1960.

2. *Brookhaven National Laboratory* (Upton, Long Island, N.Y.), was established in early 1947, and is operated for the Atomic Energy Commission under contract with Associated Universities, Inc., a private corporation sponsored by nine northeast universities: Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Princeton, Pennsylvania, Rochester, and Yale. Major facilities at the laboratory for use in biological and medical research programs include a whole body counter, a low-level radiochemistry laboratory, the world's first research reactor designed exclusively for medical studies, a ten-acre field for experimental gamma irradiation of plants and a smaller greenhouse gamma source. The Cosmotron, a 3-billion-electron-volt accelerator used primarily for physics research, is used also in biomedical studies. The biology program includes studies on biological effects of radiation mainly in genetics, cytology, biochemistry, and physiology. Medical studies emphasize particulate radiations of very short range including precise localization and distribution of radioisotopes. Neutron irradiation of certain types of brain tumors is carried out in the new medical research reactor; the reactor also produces short-lived radioisotopes useful in medical diagnosis. Brookhaven scientists conduct the continuing Marshall Islands sur-

vey of inhabitants of the Pacific Islands accidently exposed to fallout from a weapons test in 1954. The laboratory also conducts studies in micrometeorology and climatology. Health physics research investigates problems associated with very high-energy devices, waste disposal, development of special instruments and improvement of personnel monitoring techniques.

3. *Lawrence Radiation Laboratory* (University of California, Berkeley) includes the *Donner Laboratory* which traces its beginning to the first medical studies with radioactive tracer elements made in 1935 by John H. Lawrence and Joseph G. Hamilton. These investigations were made possible by the school of nuclear physics founded by Ernest O. Lawrence, and the building of the first usefully productive cyclotron under his direction in 1934. In 1940 the first of the Donner Laboratory complex was completed and directed its efforts to defense problems. Present efforts are directed toward the biological and medical applications of high-energy proton, deuteron, and alpha beams. It is the only laboratory in the world where it is possible to conduct biological studies with accelerated heavier ions (e.g. carbon, nitrogen, oxygen, and neon). Molecular and cellular level studies have been conducted leading to synthesis of complex tracers and elucidation of mechanisms of cell division. Radioactive tracer techniques have been applied to problems of body metabolism. Basic investigations of many diseases including cancer, leukemia, polycythemia vera, diabetes, pituitary tumors, and anemias have been in progress for many years. Problems of aging and endocrine factors in cancer are under study. Irradiation of the pituitary gland by high-energy protons or alpha particles in certain cancers and other diseases where endocrine imbalance is suspected is a recently opened avenue of investigation. Notable work is being done on photosynthesis. The laboratory has a unique assemblage of sophisticated scientific equipment, including a low-pressure chamber in which oxygen environments of high altitudes can be simulated, and high-energy particle accelerators for use in biomedical studies.

4. *Los Alamos Scientific Laboratory* (Los Alamos, N. Mex.): The Los Alamos Scientific Laboratory was established in 1943 for research and development concerned with nuclear weapons. The handling of plutonium in weapons development led to the establishment of a *Biomedical Research Division.* While most of the activities of this group have been directed more toward weapons research, development, and testing, many of the problems encountered have required basic research in radiation biology, in the physiology and effects of a variety of radioactive isotopes and fission products, and in the development and application of scintillation counting techniques including whole body counting methods. Total body radiation counters are among the unique facilities of this laboratory. In addition, the short-burst facility presents opportunity for biomedical studies on the effects of short-duration high-intensity radiation.

5. *Oak Ridge National Laboratory* (Oak Ridge, Tenn.): Oak Ridge National Laboratory, designated "X–10" during World War II, was designed and built in 1943 by E. I. du Pont de Nemours & Co. as a small pilot plant on which the design of the huge plutonium plant at Hanford Engineer Works was based. The plant was supervised by the University of Chicago until July 1945, when it was taken over by the Monsanto Chemical Co. for operation as a nuclear research center,

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called Clinton Laboratories. In March 1948, Carbide & Carbon Chemicals Co. (now Union Carbide Nuclear Co.) began operation at the facility now named Oak Ridge National Laboratory. A $20 million program of construction and improvement leading to a permanent national laboratory was begun in 1949. Facilities include a radioisotope-processing area, a pilot plant for chemical process development, a new research building and a high-voltage building housing a 3-million-electron-volt Van de Graaff particle accelerator, a 5-Mev. Van de Graaff, a Crockroft-Walton accelerator, and related equipment. The *Biology Division* of the laboratory studies the mechanisms of radiation effects in biological systems in an effort to design means of protection against radiation damage and of counteracting the damage after radiation has been absorbed. The approach has been largely along genetical and cytological lines, with heavy emphasis on biochemistry and biophysics. Although much of the work has been concerned with cellular level effects, there is increasing emphasis on mammalian systems. The Oak Ridge National Laboratory is the site of the commission's major program in mammalian genetics and utilizes in this work a colony of several hundred thousand mice. The Health Physics Division conducts research in radiation dosimetry and instrumentation, and plays a major part in developing permissible levels of exposure to radioisotopes. Special studies are conducted by the group because of the availability of certain unique facilities such as the dry bed of White Oak Lake which contains the residue of radioactive materials once impounded there. Plants and animals growing on the lake bed and environs are studied for uptake and effects of certain radioisotopes, especially cesium 137 and strontium 90. The *Health Physics group* also conducts studies of the waste management practices of the laboratory and plant which discharge low-level wastes into the Clinch River system. Dispersion of waste materials is studied along with uptake studies on local flora and fauna.

e. *The secondary onsite laboratories* of AEC, for the purposes of this report, consist of the following Government-owned facilities: Atomic Bomb Casualty Commission, Argonne Cancer Research Hospital, Hanford Atomic Products Operation, New York Health and Safety Laboratory, Oak Ridge Institute of Nuclear Studies, University of California (Los Angeles) atomic energy project, University of Rochester atomic energy project, University of Tennessee/AEC Agricultural Research Laboratory, and the Eniwetok Marine-Biological Laboratory. The University of Washington Laboratory of Radiation Biology is normally considered an onsite laboratory for budgetary purposes, but the facilities are not AEC-owned.

1. *The Atomic Bomb Casualty Commission* (Hiroshima and Nagasaki, Japan), was established by direction of the President on November 26, 1946, to provide a research organization for the study of human beings who had been subjected to the radiation from nuclear explosions. The program is under the direction of the National Research Council and is supported by the Atomic Energy Commission. (See further details on ABCC listed under the activities of the National Academy of Sciences-National Research Council.)

2. *The Argonne Cancer Research Hospital* (Chicago, Ill.), operated by the University of Chicago, was completed in early 1952 and made an integral part of the Billings Hospital, both of which are closely associated with the Medical School. The establishment of this

cancer hospital was authorized by the President for the primary purpose of exploring diagnosis and treatment of cancer patients. The program is oriented primarily toward metabolic studies and the therapeutic use of high energy particle accelerators, but pursues other promising leads, though peripheral, to the cancer problem. Along with the main mission of conducting extensive studies on hospitalized patients using radioisotopes for diagnosis and treatment and as tracers in metabolic experiments, opportunity is afforded to assess the therapeutic value of various teletherapy devices, including a cobalt-60 unit, a 2 Mev. Van de Graaff, and a 50 Mev. linear accelerator.

3. *Hanford Atomic Products Operation* (Hanford, Wash.): With the startup of plutonium production facilities in 1944–45, a continuing biological research program was required to study the metabolism and biological effects of plutonium and fission products. Ecological studies to measure any effect of reactor effluents released to the Columbia River were also initiated. Long-term feeding experiments are carried out with animals, employing various fission products and waste materials. Particular attention is directed toward radiation effects on nucleic acid metabolism in the gastrointestinal tract. Studies concerning removal of internally deposited isotopes from the body, and studies of factors affecting the permeability and absorptive properties of cells toward radioactive materials, are also being pursued. A unique colony of minature swine as an experiment animal is maintained at Hanford. Health physics studies include the ecological work, monitoring devices and methods for personnel protection.

4. *Health and Safety Laboratory* (New York, N.Y.), established in 1947, is operated directly (i.e. not through a contractor) by the *Commission's New York Operations Office* to assist the Division of Biology and Medicine and other AEC headquarters divisions and operations offices in accomplishing program objectives in the field of health and safety. The laboratory provides radiation and toxicological health services and studies, conducts sampling and analytical work in connection with fallout from the detonation of nuclear devices, provides consulting and educational services, and develops highly specialized field and laboratory instruments. Its facilities include a data transfer and recording system, a radiation chemistry capacity with elaborate equipment, health survey and monitoring instruments, and a whole-body counter.

5. *The Oak Ridge Institute of Nuclear Studies, Inc.* (Oak Ridge, Tenn.) is an organization composed of 25 member universities in the South and Southwest. Chartered in 1946 by the State of Tennessee, its general purposes are: (1) to stimulate cooperation between the Government and participating universities in undertaking fundamental research in the field of atomic energy, (2) to foster increased opportunities and improve programs of graduate study and education in nuclear energy in educational institutions in the South, (3) to aid in the acquisition and training of scientific personnel, and (4) to utilize the unique facilities in the Oak Ridge area for graduate research and instruction. One program in support of these basic aims is a series of basic and advanced courses in the safe and efficient handling of radioisotopes. More than 3,000 scientists have come from every State and from more than 45 foreign countries to take these courses. The institute also conducts long-range studies in the use

of atomic energy in treating malignant diseases. Medical research and clinical studies including diagnosis and treatment are pursued. A 30-bed hospital, together with newly developed and improved teletherapy devices for cancer studies comprise special medical facilities available at the institute.

6. *University of California, atomic energy project* (Los Angeles, Calif.): The atomic energy project at the University of California was established in 1947. It has been concerned with three main lines of research: environmental contamination, effects of radiation on the mammal, and instrumentation for biological research, including pioneering work on semi-conductors. The program typically has dealt with a broad examination of the various facets of each of these categories, and has included studies on lipid metabolism, chronic effects of irradiation, and the pharmacology and toxicology of agents related to irradiation. The laboratory maintains a distinctly programmatic outlook which has consistently resulted in data, techniques, and equipment of special value to many aspects of the Commission as a whole.

7. *University of Rochester, atomic energy project* (Rochester, N.Y.): The University of Rochester atomic energy project had its beginning in 1943 under the Manhattan Engineer District. Its first mission was to develop experimental data that would enable the establishment of safe levels of exposure to various chemical and radioactive substances used in the development of the atomic bomb. The Commission continues to rely on this laboratory for much of its toxicological information. The *Division of Pharmacology* has studied the toxicity, retention, excretion, and movement within the body of materials in the atomic energy program suspected of chemical or radiological toxicity or other detrimental effects, e.g. uranium, thorium, radium, radon, beryllium, polonium, thallium, indium, and mercury. An inhalation laboratory is equipped to study the relationship of various particle sizes to the inhalation, retention and distribution of aerosols. Other studies at the project are devoted to bone metabolism, the transport of ions across cell membranes, aspects of chronic radiation damage and recovery, amino acid metabolism, clinical procedures for promoting recovery from radiation damage. Increasing attention has been given long-term low-level effects of radiation in several species of laboratory animals.

8. *University of Tennessee/AEC Agricultural Research Laboratory* (Oak Ridge, Tenn.) is operated for the Commission by the University of Tennessee College of Agriculture. It conducts a program of radiobiological research of agricultural implication including work with domestic animals and studies on plant breeding in relation to radiation. The facilities for research, located on the Oak Ridge site, include a large acreage of improved farmland, a research laboratory, greenhouse, nutrition barn, and a unique type of gamma irradiation field and associated structures for studying the effects of whole-body external radiation on large animals such as burros. In addition, an external irradiation facility for plant and seed exposures is provided for UT-AEC use and is available to the southern agricultural experiment stations through a cooperative arrangement with the Agricultural Research Laboratory.

9. *Laboratory of Radiation Biology* (University of Washington, Seattle) was established in 1943 to conduct studies of the effects of radiation upon aquatic animals. The laboratory has made radiation

monitoring studies in the Pacific since the Crossroads test of 1946. Field studies are conducted on biological aspects of radiation and radioactive contamination where atomic bombs have been tested, such as at Bikini and Eniwetok Atolls. Cooperative studies with the Hanford Atomic Products Operation are carried out to determine the genetic, developmental, and other effects on marine organisms of reactor effluents in the Columbia River. The Eniwetok Marine Biological Laboratory (administered by the University of Hawaii) is available for use by the scientists from the Laboratory of Radiation Biology and from other laboratories for research which can be carried out most advantageously on a central Pacific atoll.

f. *"U.S. offsite facility"* research program in 1959 was conducted through 569 contracts with approximately 220 individual universities and research institutes, and with private, State and Federal laboratories.

g. *The "foreign offsite facility"* program in 1959 was conducted through 10 contracts with university and other research stations in 7 foreign countries and Puerto Rico:

Austria: IAEA.
Bermuda: Bermuda Biological Station for Research, Inc.
Costa Rica: Inter American Institute of Agricultural Sciences.
Israel: Weizmann Institute of Science.
Italy:
Naples Zoological Station.
University of Pavia.
New Zealand: Department of Scientific and Industrial Research.
Puerto Rico: University of Puerto Rico.
Uruguay: University of Montevideo.

h. *Government laboratories* conduct research for the AEC, under contract with the *Division of Biology and Medicine*, and the *Division of Reactor Development*. These laboratories are operated by personnel of U.S. Geological Survey, U.S. Public Health Service, U.S. Coast and Geodetic Survey, and U.S. Weather Bureau, U.S. Department of Agriculture, U.S. Department of Commerce (National Bureau of Standards).

3. SPECIAL COMMENTS AND WHY THE WORK IS DONE

i. *Radiation biology.*—In one sense, this category comprises all studies of the effects of radiation on living material. For this compilation, however, it is taken to comprise fundamental studies that emphasize the detection and evaluation of radiation effects at the subcellular level, and in cells, tissues, organs and organisms. The purpose of these studies is twofold; (*a*) to increase our knowledge of fundamental life processes through the use of radiation and radioactive materials as unique tools; (*b*) to provide better understanding of radiation damage, and ways of preventing it, in persons who may be subjected to radiation exposures in the course of AEC operations.

j. *Radiation genetics.*—Radiation-induced genetic damage can become a part of the heritage of many generations subsequent to the one exposed. Considerations of genetic damage underlie most decisions regarding the limits of radiation exposure that are presently accepted as permissible for both occupational and nonoccupational situations. Consequently, the study of the genetic effects of radiation

in man, plants, and animals has become a major research category of particular significance to the AEC.

k. *Environmental radiation.*—AEC conducts such studies to determine the effects on man of the addition of radioactivity to his environment. Emphasis is upon the effects on communities of organisms, as such effects relate to ecological phenomena including population dynamics, behavior and reproductive success. Information is obtained concerning natural forces that determine the fate of radiochemicals in the environment in terms of dispersion and reconcentration, sedimentation, diffusion and other biological and physical environmental phenomena. Studies are conducted in meteorology, fallout and environmental contamination to determine the processes by which atmospheric contaminants are transported, dispersed and deposited, and to test theories regarding mechanisms of distribution and uptake, as well as to determine actual current levels of environmental contamination.

l. *Radiation toxicology.*—Radiotoxic effects of radioisotopes on man, and on his food chain of plants and animals, are potentially limiting factors in the full development of nuclear energy. The manner in which internally deposited isotopes are metabolized, and the biological damage which these isotopes do during their passage through the organism, are problems of great complexity. Because of the highly practical necessity for data on these questions, AEC has stimulated research and has developed competent scientists in this field.

m. *Radiation protection.*—Protection of health and promotion of safety during research and production activities is a statutory responsibility of AEC. To these ends, procedures (including management of radioactive wastes and possible procedures for ultimate disposal) are developed for limiting irradiation of personnel, and for the medical treatment of cases of overexposure.

n. *Agriculture.*—The AEC has three major interests in agricultural research: (1) radioisotopes and radiation techniques are evaluated for their usefulness in improving the yield and quality of economically important crops and domestic animals; (2) radiation injury is studied in plants and animals in order to establish the capabilities of economic species under increased radiation exposure; (3) the incorporation of environmental fission products in domestic plants and animals is studied since the radioactive burden in man is predominantly acquired through food consumption.

o. *Medical applications.*—Radiation is known to be a causative agent in the genesis of cancer and leukemia. Through its destructive effects on cells, radiation is known also to have application to the destruction of cancer in the living body. AEC interest gives specific attention to distinguishing the role of radiation as just one of a number of known etiological agents capable of evoking the neoplastic response, and hence does not conflict with the interests of other groups studying carcinogenesis. AEC also develops equipment and methods for the therapeutic treatment of cancer and some other diseases with radiations from various radioisotopes, both externally and internally applied.

p. *Radiation detection and measurement.*—Quantitative correlation between the biological effects of radiation and the amount and kind of radiation required to produce these effects is essential to radiobiological research. The development of new or better instruments

for determining the character of the radiation, and the amount of energy delivered to the site of interest, are prerequisites to biomedical research and control of radiation hazards.

q. *Education, training, and information.*—Educational programs, beginning with the high school level, and extending into graduate schools, are fostered by means of faculty training and grants of specialized equipment to encourage course work in radiobiology. The purpose is to enable people to live in the atomic age without undue fear of radiation, and to encourage potential scientists to enter the fields of radiation biology and medicine. More specialized training in both universities and AEC laboratories enables scientists and medical men, including some non-Americans, to do radiation research and to protect health. Informational programs, conferences and exhibits, at home and abroad, promote these objectives.

r. *Education and training of foreign nationals* is conducted in nuclear science and technology, through the operation of schools, funding of international conferences, exhibits and studies, and in the provision of special equipment to these projects. Of the fiscal year 1959 total of $1,413,400, approximately $901,200 is estimated to have been expended in the interests of the life sciences. In addition to participation in these specific training programs, many dozens of alien scientists study or participate in research in AEC laboratories for periods of 1 to 24 months. During the period 1956–59, 217 scientists came to the United States from 51 countries to study in health physics, medicine, biology and agriculture. Costs for this kind of training are more logically considered to be part of the research costs, and hence are not shown here as part of category 9. The category does include $512,200 for cooperative AEC/ICA grants for biomedical research and training equipment to Argentina, Chile, Colombia, Guatemala, Ireland, Lebanon, and Peru.

s. *Continuing programs* of research in the various categories reported here are carried out as part of the continuing mission of the AEC. Major emphasis may shift between categories at the various laboratories, depending upon programmatic needs and available scientists.

4. RELATIONSHIPS

t. *Radiation biology and genetics.*—AEC research is confined to radiation effects insofar as possible, and close liaison is maintained with other organizations to avoid duplication of programs. AEC and contractor personnel serve as follows: as members and observers on National Institutes of Health study sections, with right to comment, and conduct an unofficial exchange of information about their projects; on National Science Foundation genetics panel; on various National Academy of Science committees; as assistants to the U.S. representative to the United Nations Scientific Committee; attend United Nations and World Health Organization conferences; participate in American Institute of Biological Sciences lecture tours to colleges in the United States and South America; participate in U.S., European and Australasian meetings and symposia and invite joint participation by foreign scientists; conduct particular conferences and exchange of information on fallout with Canada and the United Kingdom (Tripartite Conferences). Research projects are supported in Italy, Uruguay, and Chile.

u. *Environmental radiation.*—AEC has membership on Interdepartmental Committee on Community Air Pollution; Interdepartmental Committee on Atmospheric Sciences, Interdepartmental Committees on Ecology, for certain projects on the use of nuclear explosions for peaceful purposes; Interdepartmental (informal) Committee on Oceanography; Federal Council for Science and Technology, Subcommittee on Oceanography. AEC has nonmember representation on: National Academy of Science "Committee on meteorological aspects of effects of atomic radiation"; International Geophysical Year oceanographic panel. AEC has informal contacts and meetings with: U.N. Scientific Committee through regular channels; Canada and the United Kingdom for exchange of fallout and uptake measurements; Special Committee on Oceanography, of International Committee of Scientific Unions; Japanese Ministry of Fisheries and Japanese AEC, for Pacific radioactivity studies; scientific societies with joint projects for the United States such as the American Institute of Biological Sciences, American Association for Advancement of Science, Ecological Society of America. AEC conducts joint sponsorship of: interagency cooperative agreements in meteorology, involving transfer of funds, with U.S. Weather Bureau, Public Health Service, Air Force, Naval Research Laboratory; interagency cooperative agreements in oceanography, with Department of Interior Bureau of Fisheries, Coast and Geodetic Survey, Public Health Service, Department of the Navy, Food and Drug Administration; NAS Committee on Oceanography; International Congress on Oceanography (New York, 1959); International Botannical Congress, Monaco Scientific Conference on Disposal of Radioactive Wastes (AEC–ICA–IAEA), involving oceanographic disposal; with Government of New Zealand, collection and analysis of environmental samples of cesium and strontium; with Israel and Sweden, sampling and analysis of tritium in the atmosphere. AEC reports are given worldwide distribution through Technical Information Services Exchange, AEC depositories, U.N. Scientific Committee and direct mailing lists.

v. *Radiation toxicology.*—AEC and contractor personnel serve on various subcommittees of the International Commission on Radiological Protection, National Committee on Radiation Protection and Measurement, and U.N. Scientific Committee, thus bringing the latest results of their research to bear on the recommendations of these committees. They maintain liaison with the armed services and Public Health Service, and have a member on the Air Force Life Science Advisory Committee.

w. *Radiation protection.*—AEC and contractor personnel serve on the various subcommittees of American Standards Association, National Committee on Radiation Protection and Measurement, and International Commission on Radiological Protection and hence bring to these groups the latest results of their research in radiation protection. They also participate in the International Labor Office and International Atomic Energy Agency conferences, and symposia on radiation protection such as Pan-American and European. AEC jointly sponsors health physics courses with World Health Organization, such as those given in Sweden, Belgium and India recently. Cooperative studies in waste management are conducted with various governmental agencies, and conferences are held with professional and quasi-governmental groups such as Columbia River

Advisory Group, Mohawk River Advisory Committee, American Water Works Association, Conference of State Sanitary Engineers, Water Pollution Control Association.

x. *Agriculture.*—In the application of radiation to agriculture, close liaison is maintained with the U.S. Department of Agriculture and State agricultural research stations through cooperative research projects, particularly in plant breeding. Foreign research projects, including gamma radiation fields, are supported jointly with agricultural research stations in Costa Rica, Italy, and Argentina. Training programs are supported jointly with Food and Agriculture Organization of the United Nations, and staff members consult with FAO, International Atomic Energy Agency and UNESCO. Symposia have been supported with National Science Foundation and USDA on radioisotopes in the biosphere and food chain, and a tripartite meeting has been held on these subjects. A systematic bibliography is being developed on plant radiation biology, including agricultural aspects.

y. *Medical applications.*—AEC maintains close liaison with the Radiation Study Section of the National Institutes of Health for the exchange of information and avoidance of duplication in research. An AEC representative participates in meetings of the National Advisory Cancer Council, which is advisory to the Surgeon General of the Public Health Service and to the National Cancer Institute. The staff participates in symposia such as the Puerto Rico Symposia on Legal and Administrative Problems, and is represented at various national and international conferences.

z. *Radiation detection and measurement.*—AEC staff members serve on the Instrument Advisory Committee for Office of Civil and Defense Mobilization, and attend meetings of the Defense Atomic Support Agency Panel on Radiological Instruments, which serves to bring all services and agencies together, thus avoiding gross duplication of effort. There is a joint instrument evaluation program with the U.S. National Bureau of Standards. AEC participates in instrument conferences held by Institute of Radio Engineers, Instrument Society of America and Health Physics Society, and in the Geneva and tripartite (U.S.-U.K.-Canada) meetings which are held every 2 to 3 years. It is represented on the committee on instrumentation of the American Standards Association. It will participate in the proposed IAEA conference on "mixed radiations dosimetry and its application to radiation accidents".

zz. *Education, training, and information.*—All AEC domestic programs are coordinated with other agencies interested in training. Fellowship programs are coordinated with National Science Foundation and are limited to training in specific atomic energy fields. Institutes for faculty training in radiobiology are financed and administered jointly with NSF. Equipment grants are coordinated informally with NIH (Division of General Medical Science, Training Program) when construction funds are involved.

B. U.S. Department of Agriculture

The Department of Agriculture was created by act of Congress in 1862. In 1889, it became an executive department in the Federal Government, and its Commissioner became the Secretary of Agriculture. Among other functions, the Department conducts basic and

applied research on agricultural problems, and makes research results available for practical farm application through extension and experimental station work in cooperation with the States. The Agricultural Research Service, under the Assistant Secretary for Federal-States Relations, consolidates most of the physical, biological, chemical and engineering research in the Department. The Agricultural Marketing Service which also conducts research, reports to the Assistant Secretary for Marketing and Foreign Agriculture.

TABLE A.—U.S. DEPARTMENT OF AGRICULTURE

BUDGETARY AND MANPOWER DATA

(Fiscal year 1959, obligated)

[Dollars in thousands]

Research category [1]	Number of projects	Funds	Man-years	
			Scientific	Supporting
6. Agriculture:				
USDA	23	$119.8	10.8	10.9
State grants	50	195.3		

[1] See table A for AEC for a listing of the 10 categories considered within this compendium concerning radiation research, p. 26.

TABLE B.—U.S. DEPARTMENT OF AGRICULTURE

ORGANIZATIONAL DATA

Research category [1]	Special comment	Who	Where	When	Why	Relationships
6. Agriculture	2a	2b	2c	2d	2e	2f.

[1] See table A for AEC for a listing of the 10 categories considered within this compendium concerning radiation research, p. 26.

2a. The figures include projects covering all fields of agricultural research, but not necessarily at the level of the basic disciplines. For example, the Entomology Research Division's projects on radiation effect on insects is not basically directed to studies of genetic phenomena nor to development of mutants, but from this research was developed the apparently successful screwworm eradication project, a joint effort of the Department and the State of Florida, involving a 1959 expenditure of $2,040,000.

2b. Work involving radiation effects on animals and plants comprises an integral part of the Department's research program: In Agricultural Research Service, the Divisions of Animal Husbandry, Crops Research, Utilization Research and Development, and Entomology Research; in Agricultural Marketing Service, the Biological Sciences Branch.

2c. Radiation facilities of the Department are rather varied and widely separated. At Plant Industry Station, Beltsville, Md., a 100 kv. X-ray source and a nominal 1 curie cobalt 60 source are available. Entomology research has radioisotope and radiation laboratories at Orlando, Fla., and Honolulu, Hawaii, which have cobalt 60 sources of approximately 400 curies each with treatment volumes of approximately 2.5 liters, as well as an 80-curie cobalt irradiator at

Corvallis, Oreg. Utilization Research and Development has a 1,000-curie cobalt 60 unit at the New Orleans, La., Laboratory. (The screwworm eradication project has six semiautomatic irradiation units of approximately 600 curies each, as well as an X-ray unit at the installation in Sebring, Fla.) A very considerable part of the effort is carried out in cooperation, generally by memoranda of understanding rather than by specific cooperative projects, with the State agricultural experiment stations, land-grant colleges, or State universities. Agricultural Marketing Service has its principal project in cooperation with the Quartermaster Corp., Chicago, which utilizes the facilities of the Argonne National Laboratory. One of the entomology research current projects, located in Mexico City, is carried out in radiation facilities of Hospital Instituto del Seguro Socil; another uses facilities at the University of Texas. Direct contract research plays a relatively minor role. During the past year there were two active contracts in this field, with Massachusetts Institute of Technology and the University of Illinois, involving approximately $35,000 and 3 scientific man-years for fiscal year 1959. It is anticipated that these will be completed this year. The support of research in the effects of radiation is indicated by Department's Federal grants to State experiment stations which totaled $195,345.69 for fiscal year 1959.

2d. The use of radiation in the Department of Agricultural Research is a continuing and growing one, integrated into the program wherever this tool can contribute. Although the present status has developed primarily over the past 5 or 6 years, investigations on the effect of radiation of plants (corn and tobacco) were initiated over 20 years ago. Plans for the immediate future provide for increasing the number and type of source available to provide greater flexibility in the application of radiation to research problems.

2e. For the most part, the effect of radiation serves the Department's program as a means rather than an end and the significance of the effort is to be found largely in the contribution to the successful completion of research.

2f. The Department is represented on interagency groups, advisory boards or committees concerned with this field, usually through the Office of the Administrator of the Agricultural Research Service or the Office of the Administrator of the Agricultural Marketing Service. Reports on progress move through staff channels to the Administrator, Agricultural Research Service, which office is also charged with responsibility for departmentwide coordination of research. Liaison is maintained with Foreign Agricultural Service, ICA and the AEC and participation in international symposia and conferences by qualified staff members is encouraged.

C. U.S. Department of Commerce (National Bureau of Standards)

The U.S. Department of Commerce, established in 1913, is an executive department in the Federal Government. It has as one of its statutory functions that of fostering, promoting and developing foreign and domestic commerce, including the function now assigned to its National Bureau of Standards, namely, the custody, maintenance and development of national standards of measurement for physical quantities such as length, mass, time, radioactivity, etc. The Bureau is one of a number of technical bureaus in the Department,

and reports through its Director to the Assistant Secretary of Commerce for Domestic Affairs.

TABLE A.—U.S. DEPARTMENT OF COMMERCE

BUDGETARY AND MANPOWER DATA

(Fiscal year 1959, obligated)

[Dollars in thousands]

Research category	Number of projects	Funds		Man-years	
		Agency	Amount	Scientific	Supporting
5. Radiation protection	20	NBS	$299.8	29	15
		AEC	108.1		
		DOD	136.7		
		OCDM	103.1		
		Total	647.7		
8. Radiation detection and measurement	17	NBS	294.1	26	17
		AEC	252.7		
		DOD	48.5		
		OCDM	19.5		
		Total	614.8		
Total			1,262.5	55	32

TABLE B.—U.S. DEPARTMENT OF COMMERCE

ORGANIZATIONAL DATA

Research category	Special comment on research categories	Who	Where	When	Why	Relationships
Radiation protection	3a	3b	3c	3d	3e	3 f, g, h.
Radiation detection and measurement.	3a	3b	3c	3d	3e	3 f, g, h.

3a. Slightly more than half the research conducted by the National Bureau of Standards in these categories is done under contract with, and using funds from, the Atomic Energy Commission, Department of Defense, and Office of Civil and Defense Mobilization, as indicated in table A.

3b. Radiation studies are done in the *Radiation Physics Division*, National Bureau of Standards, Department of Commerce, which reports to the Deputy Director and Director of the National Bureau of Standards. It is one of the 12 technical divisions of the National Bureau of Standards located in Washington, D.C. The present staff consists of approximately 58 professional personnel, all specially trained in radiation work, and including 26 scientists with the Ph. D. degree. It is supported by approximately 28 subprofessional and administrative personnel.

3c. Facilities of the Bureau, in Washington, D.C., consist of normal laboratory facilities and three special buildings designed primarily for radiation research. In one of the other conventional NBS buildings there are laboratories, including special "hot" laboratories, designed especially for handling radioactive materials. The three special buildings are designed with radiation shielding facilities: (a) *High*

Voltage Laboratory is a 5-story building with basement and penthouse facilities, containing a 1½-million-volt electron accelerator for producing X-rays and electrons, a 2-million-volt neutron generator, a 500,000-volt electron accelerator, numerous X-ray sources ranging up to 250 kilovolts and sealed sources of radioactivity for instrument studies. Special electrical supply systems are used to maintain the constancy of output on the accelerators; (b) *Betatron Building* contains a 180-Mev synchrotron and a 50-Mev betatron together with special shielding facilities and instrumentation rooms; (c) *Gamma Ray Laboratory*, designed for handling sealed gamma-ray sources, is isolated from other buildings. In addition to normal radioactivity facilities it includes sealed sources containing about 2,500 curies of cobalt 60. The procurement of a new source of 60,000 curies is in process.

3d. The program is conducted on a regular and continuous basis, and has been growing since 1927. The direction of effort changes from time to time according to current advances in science. Its basic effort is concerned with problems of radiation protection, measurement and dosimetry, and interaction of radiation and matter. A new and expanded facility is planned for the new site, to include a high-energy, high-intensity linear accelerator. The program with this will include basic research as well as research in radiation dosimetry and protection.

3e. The entire radiation program is in accordance with the following statutory responsibilities of the National Bureau of Standards: "(9) The investigation of radiation, radioactive substances, and X-rays, their uses, and means of protection of persons from their harmful effects" (15 U.S.C. 272). Practically all activities in the radiation field are automatically dependent upon NBS dosimetry standards and measurement standards for the validity of their measurements and for the efficient interchange of meaningful data between separate laboratories and the consistency with which the results of their work can be applied to the interpretation of data. NBS also provides a number of critically important benchmarks for the research, production and utilization of ionizing radiation in all forms, such as determination of fundamental constants and spectra, shielding measurements and the establishment of standards for the measurement of radiation intensity, exposure dose and absorbed dose. These benchmarks are indispensable for radiation applications in medicine, industry, nuclear energy and the general environment.

3f. The NBS radiation program maintains active relationships with other *Governmental organizations*, such as with the AEC at both the administrative and working level. A variety of research programs relating to radiation protection and measurements have been supported in part by the AEC for many years. Partly through this mechanism, the NBS radiation physics program is kept aware of the AEC needs, and its programs are adjusted as needs change or develop. Some members of the NBS research staff are invited from time to time to attend meetings and present information to various AEC committees, such as the Advisory Committee on Biology and Medicine and the General Advisory Committee. NBS staff members are members of other AEC advisory committees. Working relationships exist with the Public Health Service, through fairly close but informal contact at the working level. Recently one NBS staff member has been made a member of a National Advisory Committee on Radiation that reports to the Surgeon General. Very close working relationships

exist with various parts of the Department of Defense. This has been particularly so with AFSWP (now DASA) which has supported work at NBS, and NBS has in turn assisted them in many problems in the radiation field. The NBS also has research contracts with the Army, Navy, and Air Force. Some of these deal with the broad problems of radiac instrumentation and NBS staff members attend meetings of the DOD on this subject. There are also working relationships with the Air Force Operations Analysis Division and the Weapons Systems Evaluation Group of the Joint Chiefs of Staff, and between radiation programs of the NBS and the Office of Naval Research. NBS has worked closely with FCDA (now OCDM), including a continuing program of research relating to their instrumentation problems. The NBS is also their primary source of guidance on matters of radiation shielding generally, and protection offered by buildings and shelters in particular. This protection program is also tied in with the AEC and DOD programs of similar nature. The NBS radiation program has for a number of years provided a close relationship with all the above agencies in the instrumentation field. Studies performed for one group are reported to all others, resulting in a reduction of otherwise overlapping programs. Through the Department of Commerce, the NBS has been very active on the Interdepartmental Committee of Radiation Preservation of Foods.

3g. Connections with non-governmental organizations have been an important and essential part of the radiation activity at the NBS, beginning in 1927 with the establishment of the radiation program at the NBS. NBS staff members have been members of, or chairmen of, practically every technical committee dealing with radiation protection and measurement in this country for the past 32 years. Through this means the NBS has maintained knowledge of the research and development needs for medical, industrial and research organizations, and has been able to feed information into these organizations in such a way as to greatly facilitate the quick usage of new information. There are 15 or 20 such organizational relationships, such as the following:

National Committee on Radiation Protection and Measurements (*NCRP*), originally known as the Advisory Committee on X-ray and Radium Protection, came into being in the United States in 1929 upon the recommendation of the International Commission on Radiological Protection. NBS undertook to organize and sponsor the committee, at the request of a number of technical societies. While the NBS has been the administrative sponsor of the NCRP, the program and policies of the committee have been managed by a group jointly representing the 18 other sponsors. The committee has, since its inception in 1929, provided the basic guidelines for radiation protection and measurements in this country. It has also been a major contributor to the ICRP, with the result that the current international recommendations reflect much of the U.S. thinking. One of its principal means of disseminating information in the areas of radiation protection and measurements is through reports of the NCRP which are published as NBS handbooks in accordance with the statutory authority of the NBS. Something over one-half million copies of these handbooks have been distributed through the Government Printing Office since the publication of the first one in 1931. (Most of the primary research results on radiation protection and measurements are disseminated through publications in conventional NBS and outside scientific journals).

American Standards Association.—Since 1943, NBS has sponsored the ASA Committee on X-ray and Radium Protection. Since the establishment of the Nuclear Standards Board by the ASA, the NBS has had staff members on many of its committees and subcommittees.

National Academy of Sciences.—Since the establishment of the NAS Advisory Committee on Civil Defense, NBS has had a staff member on that committee, and for the past 2 years has provided the chairmanship. This is a typical committee type of operation leading to close working relationships between NBS, OCDM, NAS, and DOD, and to better coordination of certain civil defense programs concerned with radiation problems.

3h. The NBS works closely with *international bodies* such as: the International Bureau of Weights and Measures (either through direct relations by U.S. treaty or through the ICRP or ICRU); the International Atomic Energy Agency (through the AEC, ICRP and ICRU); the World Health Organization (through the ICRP and ICRU). There are also the regularly established working relations between the *Radiation Division* of the NBS and the corresponding divisions of international laboratories of many other countries. NBS work in the radiation field finds its way into worldwide application through such relationships. In addition, part of its output is disseminated through the publications of the ICRP and ICRU, NAS, ASA, etc.

International Commission on Radiological Protection (ICRP).—When the ICRP was organized in 1928 the NBS supplied the only U.S. representative to that body. The NBS has been continually active in the group and has supplied a large fraction of the physical data included in their reports. Biological and medical data have been of course contributed by other organizations. The ICRP has always been the internationally recognized body for the provision of radiation protection criteria and general guidelines. In 1950 the ICRP was enlarged and organized along the lines of the NCRP in this country.

International Commission on Radiological Units and Measurements (ICRU).—From the period of 1928 to 1950 the NBS supplied one of the two U.S. representatives to the ICRU. It also provided the secretary for the ICRU from 1934 to 1950, and the chairman from 1953 to date. A major portion of the current recommendations of the ICRU is based on technical data provided by NBS and collected through the NCRP.

D. U.S. Department of Defense

The Department of Defense was established as an executive department of the Government in 1949, under the civilian control of the Secretary of Defense. To eliminate unnecessary duplication, particularly in the field of research and development, its overall direction and control are vested in the *Director of Defense Research and Engineering* who has ultimate responsibility for all of the Defense Department programs included in this report. However, the Army, Navy, and Air Force are the principal operating organizations which plan, support, and coordinate research and education in radiobiology through grants, contracts, and work in laboratories maintained by the three services. While these activities are conducted primarily for their applicability to military responsibilities, all have their place in peaceful applications of nuclear energy and hence are reported in this compendium.

TABLE A.—U.S. DEPARTMENT OF DEFENSE

BUDGETARY AND MANPOWER DATA

(Fiscal year 1959, obligated)

[Dollars in thousands]

Category	Army				Navy				Air Force				Total			
	Number of projects	Funds	Man-years		Number of projects	Funds	Man-years		Number of projects	Funds	Man-years		Number of projects	Funds	Man-years	
			Professional	Supporting			Professional	Supporting			Professional	Supporting			Professional	Supporting
1. Radiation biology	21	$597.0	28.3	10.5	5	$603.0	33.0	37.0	23	$981	45.0	103.25	49	$2,181.0	106.3	150.75
2. Radiation genetics	1	25.0	1.3	.4									1	25.0	1.3	.4
3. Environmental radiation	2	67.0	3.5	.9					2	48	3.0	2.7	4	115.0	6.5	3.6
4. Radiation toxicology	27	859.0	45.0	13.0					1	25	1.0	.75	28	884.0	46.0	13.75
5. Radiation protection	33	1,084.3	57.8	16.4	1	14.0	1.0	.5	2	163	4.7	14.2	36	1,261.3	63.5	31.1
7. Medical application	6	182.0	10.9	4.7	4	39.5	2.5	2.5	1	12	.3	1.0	11	233.5	13.7	8.2
8. Radiation detection and measurement	7	190.5	12.1	6.5	1	4.0		.5	3	130	3.4	4.1	11	324.5	15.5	11.1
Total	97	3,004.8	158.9	52.4	11	660.5	36.5	40.5	31	1,359	57.4	126.0	140	5,024.3	252.8	218.9

TABLE B.—U.S. DEPARTMENT OF DEFENSE

ORGANIZATIONAL DATA

Category	Special comment	Who	Where	When	Why	Relationships
1. Radiation biology	4e	4 a, b, c	4 a, b, c, f	4f	4 a, b, c, d	
2. Radiation genetics	4g	4 a, b, c, g	4 a, b, c, g	4g	4 a, b, c, g	
3. Environmental radiation	4h	4 a, b, c, h	4 a, b, c	4h	4 a, b, c, h	
4. Radiation toxicology	4i	4 a, b, c, i	4 a, b, c, i	4i	4 a, b, c, i	4i.
5. Radiation protection	4j	4 a, b, c, j	4 a, b, c, j	4j	4 a, b, c, j	
7. Medical application	4k	4 a, b, c, k	4 a, b, c, k	4k	4 a, b, c	
8. Radiation detection and measurement.	4 l	4 a, b, c, l	4 a, b, c, l	4l	4 a, b, c, l	4m.
9. Education, training, and information.	4n	4 a, b, c	4 a, b, c	4n	4 a, b, c	

4a. Responsibility of the Department of the Army in preparing land forces for nuclear action must include the attainment and dissemination of detailed knowledge of the biological effects of ionizing radiation; i.e., a suitable research program and subsequent training. Resources of the Army to accomplish the research and training goals include the *Division of Nuclear Medicine and Chemistry at Walter Reed Army Institute of Research, Washington, D.C.;* the *U.S. Army Medical Research Laboratory at Fort Knox;* the *U.S. Army Medical Research Unit at Landstuhl, Germany;* the *Radiological Laboratory at the Army Chemical Center;* the *Radiological Operations Division at the Chemical Corps Proving Ground;* the *Quartermaster Food and Container Institute at Chicago;* the *Quartermaster Research and Engineering Laboratories;* extramural research contracts and various training installations of the U.S. Army.

4b. In broad terms the Surgeon General of the Navy is responsible for safeguarding the health of personnel in the naval service. The Navy has become a principal user of nuclear power and must deal with the special problems which arise from the possibility of nuclear incidents at sea. Hence research on the biological effects of radiation and on methods for decontaminating vessels and protecting personnel is essential for successful accomplishment of its mission. The *Naval Radiological Defense Laboratory at San Francisco* and the *National Naval Medical Research Institute at Bethesda, Md.*, conduct most of the research in these areas presently being supported by the Navy. Extramural support through grants and contracts to scientific institutions is handled primarily by the *Office of Naval Research* and the *Bureau of Medicine and Surgery.* However, the extramural program of the Office of Naval Research has not emphasized radiation biology since the establishment of an extramural program by the Atomic Energy Commission. Naval officers are trained for duties involving clinical application of radioisotopes, radiobiology, radiology and medical aspects of nuclear propulsion and warfare, etc. at any of several universities, naval schools and naval or civilian hospitals.

4c. In the Air Force, it is the responsibility of the *Air Research and Development Command* to conduct biomedical and radiobiological research as it relates to (1) the testing, maintenance, and use of Air Force atomic weapons systems, and (2) the Air Force applications of nuclear energy for power. ARDC is also charged with the development of radiation detection equipment and personnel protective equipment. The School of Aviation Medicine has responsibility for eval-

uating the biological effects of radiation and analyzing anticipated radiation hazards. The varied types, ratios, energies, and schedules of nuclear radiation demanded for research represent an array of experimental radiation sources beyond the capabilities of any given installation or facility. Consequently, the challenges of the SAM program continue to be met by utilizing a combination of inhouse and extramural studies, and by collaboration between Air Force and AEC facilities in fields of basic and applied research, teaching of the developed concepts of radiobiology both to scheduled classes at the school and in the form of guidance or advisory correspondence to concerned facilities.

4d. The Armed Forces must be prepared to cope with injury caused by radiation. The military problem is concerned particularly with intermediate ranges of exposure about which relatively little is known and for which no rational therapy exists—hence the need for research on fundamental mechanisms of radiation damage. Tolerance levels of humans for radiation must be known in connection with necessary levels of decontamination of ships and in the operation of nuclear devices. The safety of foods preserved by radiation must be established.

4e. In radiation biology, investigations include: effects of ionizing radiation on body organs and on the biochemical components of these tissues, with emphasis on prompt short-term changes in the effort to understand underlying mechanisms of damage; effects on blood-forming tissue, changes in susceptibility to infection, nature of radiation burns and rate of wound healing; safety and nutritional value of foods preserved by radiation, including long-term feeding experiments with animals; measurement of free-radical formation by radiation in living cells and its effects on reproduction and cell fragmentation; effects of acute and chronic whole-body radiation on large animals closely related to man and changes produced in the central nervous system.

4f. These studies are conducted under contract by universities and institutes, and in service laboratories. Most of the projects are funded for 2 years or more.

4g. As part of a general program for establishing safety of radiation-preserved foods, the Army maintains one project to determine in experimental animals whether long-term feeding with such foods can have any detectable genetic effects. This is a continuing university project.

4h. Environmental measurements of fallout fission products and natural radioactivity in man are made through the Army Medical Service. The nature and occurrence of radiations in and above the stratosphere, and the effects of such (simulated) radiations on tissue, are studied through university contracts by the Air Force geophysics program and Aerospace Medical Center. The studies are on a continuing basis.

4i. To ascertain whether toxic products are formed by the interaction of ionizing radiations with the chemical constituents of food during preservation, the Army Medical Service is studying whether such foods cause unfavorable effects in mammals. It supports 25 extra-

mural contracts with universities and industrial laboratories, and a project at its *Nutrition Laboratory in Denver*. The *Chemical Corps* evaluates the synergistic effects of radiation and mitotic poisons. The Air Force in cooperation with the AEC at Hanford, is studying the toxicology of ingested plutonium. These projects are all on a continuing basis.

4j. In the area of protection against radiation damage the Army Medical Service has initiated a program to develop a practical method of protection by the use of chemicals; the Quartermaster Corps is attempting to confirm a suggestion that a diet rich in certain vegetables improves mammalian resistance to radiation, and, if confirmed, it plans to isolate the constituents responsible for the effect; the Navy Bureau of Medicine is studying the protective effects of injected bone marrow and the immunological reactions which occur; the Aerospace Medical Center is screening compounds for their potential value as protective agents. These programs are on a continuing basis and are conducted through extramural contracts and in service laboratories.

4k. Medical applications under study are: immunochemical and clinical studies on postirradiation therapy, including bone marrow transplantation, sponsored by the Army Medical Service at four universities; chemical substances are being studied in conjunction with radiation for their effect on leukemia, by the Chemical Corps; evaluation of new ways of using isotopes to diagnose and treat disease, by Navy Bureau of Medicine; development of diagnostic X-ray techniques which minimize exposure of patients to radiation, by Aerospace Medical Center. These are continuing projects.

4l. In the area of instrumentation for radiation detection and measurement, all services have needs for sensitive whole-body radiation counters and phantoms or models as aids in precisely detecting, measuring and calibrating radiations from different sources, as tools for interpreting field data and laboratory experiments. These developments, on a continuing basis, are mostly carried out in service laboratories.

4m. The Panel on Radiological Instruments, of the Defense Atomic Support Agency, serves to coordinate the instrument development activities of the services with those of other agencies and industry. Each service has a voting member on the panel.

4n. The services maintain schools offering training in radiation hazards, use of isotopes and sources for diagnosis and therapy, and information about new developments in radiobiology. In addition qualified military personnel attend universities and institutes for advanced education in this subject. General information on radiation has been incorporated into basic training, and military aspects of radiation biology have been integrated into the training program at all levels. This is a continuing program, at Walter Reed Army Institute of Research, Army Hospitals, University of Rochester, Reed College, Chemical Corps School, Basic Training Post, U.S. Naval Medical School, National Naval Medical Center, Naval Hospitals, Naval Schools Command, and Aerospace Medical Center.

E. Department of Health, Education, and Welfare

The Department was created by Reorganization Plan 1 of 1953, for the purpose of improving the administration of those Governmental agencies which have responsibilities for promoting the general welfare in the fields of health, education, and social security. The Department is one of the executive departments of the Federal Government, and is headed by the Secretary of Health, Education, and Welfare who holds Cabinet rank and reports directly to the President. The Department comprises 14 operating agencies and bureaus, of which only the Food and Drug Administration and the Public Health Service engaged in radiation research for the life sciences in 1959.

TABLE A.—DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE [1]

BUDGETARY AND MANPOWER DATA

(Fiscal year 1959, obligated)

[Dollars in thousands]

Category	Intramural				Extramural				Total			
	Number of projects	Funds	Man-years		Number of projects	Funds	Man-years [3]		Number of projects	Funds	Man-years [3]	
			Scientific	Supporting			Scientific	Supporting			Scientific	Supporting
1. Radiation biology	19	$594.4 [2](106.0)	18.9	10.6	117	$2,015.2			136	$2,609.6		
2. Radiation genetics	3	62.9	1.1	2.8	13	151.0			16	213.9		
3. Environmental radiation:												
PHS	22	609.3 [2](286.6)	27.3	21.0	15	154.3			38	849.2		
FDA	1	85.6	5.0	6.0								
5. Radiation protection	13	164.7 [2](1.4)	5.2	5.7	6	111.9			19	276.6		
6. Agriculture					2	25.1			2	25.1		
7. Medical applications	4	48.1	2.2	2.1	140	1,611.8			144	1,659.9		
8. Radiation detection and measurement	9	382.6	18.7	18.0	19	255.4			28	738.0		
9. Education, training, and information	6	267.0	6.3	5.0	3	53.1			9	320.1		
Total	77	2,214.6 [2](394.0)	84.7	71.4	315	4,477.9	[3] 320	[3] 373	392	6,692.5 [2](394.0)	[3] 405	[3] 444

[1] Data are those of Public Health Service, except those of Food and Drug Administration shown in category 3.

[2] Amounts shown in parentheses are funds transferred from other Government agencies.

[3] Data on man-years for extramural projects are not available. Totals shown are based on AEC experience of approximately $14,000 per scientific man-year, and a ratio of 7 supporting man-years for each 6 scientific man-years.

TABLE B.—DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

ORGANIZATIONAL DATA

Category	Special comment	Who	Where	When	Why	Relationships
1. Radiation biology	5j	5e, f, o	5h, i	5i	5g	5k, l, m.
2. Radiation genetics	5j	5e, f, o	5h, i	5i	5g	5k, l, m.
3. Environmental radiation	5j	5a, e, f, o, q, w.	5a, h, i, q, t, v.	5b, i, s	5c, g, p	5d, k, l, m, p, r.
5. Radiation protection	5j	5e, f, o, q, w.	5h, i, q, t, v, w.	5i, s	5g, p	5k, l, m, p, r.
6. Agriculture	5j	5f	5i	5i	5g	5k, l, m.
7. Medical applications	5j	5e, f	5h, i	5i	5g	5k, l, m.
8. Radiation detection and measurement.	5j	5e, f, o, q, w.	5h, i, q, t.	5i, s	5g	5k, l, m, r.
9. Education, training, and information.	5j, n	5e, f, o, q.	5h, i, n, q, u.	5s	5n	5l.

5a. *The Food and Drug Administration* has its headquarters in Washington, D.C., with an administrative, technical and service staff. Its Commissioner reports directly to the Secretary of Health, Education, and Welfare. Research is conducted in its Washington laboratories and in its 17 field district laboratories.

5b. The environmental radiation research is conducted on a regular basis since 1954. The program is expected to expand in fiscal year 1960 and thereafter.

5c. The Federal Food, Drug, and Cosmetic Act places upon FDA responsibility to enforce the national pure food and drug law in interstate commerce, including the addition of radioactivity to, or the use of radioactivity in connection with foods and drugs, intentionally or otherwise. This is primarily a consumer health protection law. FDA research is designed to furnish basic information necessary to carry out its statutory obligations.

5d. FDA maintains close informal liaison with the U.S. Public Health Service, the Atomic Energy Commission, and the Department of Agriculture to prevent unnecessary duplication and to exchange information involving research progress in areas of mutual interest. Research results may come to the attention of policymaking authorities through conferences prior to departmental releases and through FDA contributed articles to scientific journals.

5e. The *Public Health Service* was established in 1798, and became a part of DHEW by the reorganization of 1953. The PHS, under the direction of the Surgeon General, is the Federal agency charged with responsibility for protecting and improving the health of the people of the Nation. In addition, the Office of the Surgeon General has control and direction of the extramural research which is sponsored by the PHS through the various mechanisms of research grants, contracts and grants-in-aid. The Public Health Service has had projects in radiation research since the 1920's. Three major subdivisions of the PHS are: *Bureau of Medical Services*, which does not do direct research, but through its clinical activities, it has opportunity to use radioisotopes in diagnosis and treatment; *National Institutes of Health*; *Bureau of State Services*.

5f. The *National Institutes of Health* has *seven research institutes* and *a clinical center*, primarily concerned with extension of basic knowledge regarding health problems of man. These institutes, the *Division of Research Grants* and the *Division of General Medical*

Sciences provide grants-in-aid to institutions and to individuals for research and training in health-related fields, including radiation effects. Overall leadership is provided by the Director, NIH, who is responsible to the Surgeon General of the Public Health Service.

5g. Because of its primary interest in fundamental biological and medical research, the National Institutes of Health, both through intramural and extramural programs, support a limited amount of research on the sources and effects of radiation. While findings of interest and use to those directly engaged in radiological health programs may result from time to time, the limited NIH activities relating to radiation are oriented toward the acquisition of new knowledge about the mechanisms of action of ionizing radiation in biological systems, the use of radiation as a diagnostic and therapeutic tool, and epidemiological studies of the effect of longterm, low-level exposure.

5h. The major share of the *intramural research activity* in the NIH related to the effects of radiation is carried out in the laboratories of the National Cancer Institute, the National Institute of Neurological Diseases and Blindness, National Institute of Arthritis and Metabolic Diseases, and the National Institute of Dental Research. These are continuing research activities. In addition to the usual laboratory equipment, NIH has major radiation facilities and measurement instruments available as research tools, such as 2–Mev and 3–Mev Van de Graaff accelerators, 6-curie cobalt 60 irradiator, constant potential X-ray units, a scintillation spectrometer, and more powerful irradiators on order—also a low-level whole-body counter. An in-service training program has been established in this applied area, to meet the needs of the Institutes and Clinical Center.

5i. The *extramural program* of the NIH is carried out by grants to leading investigators in universities and research institutions throughout the country. Applications received from these investigators are reviewed several times a year and grants are made on an annual basis.

5j. Activities involving radiation supported through the extramural research program have been selected from (1) those proposals reviewed by the *Radiation Study Section*, (2) those reviewed by the *Sanitary Engineering and Occupational Health Study Sections*, and (3) those considered directly by the *National Advisory Dental Council*. In addition, other *study sections such as Physical Biology or Genetics* may review proposals for fundamental studies in biophysics or genetics. The views of the consultants are transmitted to National Advisory Councils who consider these views in the context of a balanced national extramural research program in their respective areas of health concern. Their recommendations go to the Surgeon General for actual approval. Likewise, field investigation grants are provided by the National Cancer Institute to support field investigations and research which will contribute to the prevention, diagnosis, and treatment of cancer. Some of these grants support work on the sources and effects of radiation as related to cancer diagnosis and therapy.

5k. Prior to free publication, all research findings derived from the intramural and extramural research programs are integrated into application, technical assistance, demonstration, and control activities of the operating programs of the Public Health Service. The rationale for the distribution pattern is based on the maintenance of the privileged nature of the information about research prior to its completion,

and the wide dissemination of information to the scientific community subsequent to its completion.

5l. *Project coordination* is achieved through day-to-day contact of scientists engaged in intramural research related to radiation and those concerned with the administration of the extramural programs in these areas. Where more formal coordination may be required, it is achieved through the regular meetings of the scientific directors and institute directors of the NIH. Coordination is achieved through: (1) continuous and free contact among NIH scientists and scientists of other agencies; (2) participation on the Radiation Study Section of leading scientists from Argonne, Brookhaven, and Oak Ridge National Laboratories, from the Atomic Energy Commission, and from the Departments of the Air Force and of the Army; (3) occasional formal discussions between AEC and NIH, on the respective agency programs and the status of all research of mutual interest; (4) free availability of information on applications for research support and on grants, through the Bio-Sciences Information Exchange which lists all projects in the biological and medical sciences supported by Federal agencies and major granting agencies including descriptive title of the research project, name of principal investigator, name of institution and providing 200-word summaries on work in progress on specific research grants. None of the research supported by the National Institutes of Health is classified. The extensive use of civilian scientists on the NIH study sections, the broad participation of NIH scientists in the open scientific community, the policy of free, prompt, and open publication—all combine to assure correlation between projects supported by funds appropriated to NIH and research supported by nongovernmental sources.

5m. Relationship with State activities and programs: both the Radiation Study Section and the Public Health Study Section have encouraged State agencies to develop scientific competence which would enable them to conduct fundamental studies on the sources and effects on radiation. Further liaison is effected through having a representative from the Bureau of State Services, Division of Radiological Health, serve as observer at meetings of the Radiation Study Section. In addition, the control, demonstration and technical assistance activities of NIH and PHS which work directly with State and local health agencies provide for direct communication of significant and useful research findings to those organizations.

5n. At NIH, emphasis is placed upon the unity of science and the totality of research support, including provision of research facilities and expansion of the scarce supply of talent through research training. These activities are not aimed at radiological health, as such. However, it is hoped that the expanded training program in the broad field of physical biology, for example, will ultimately contribute to the more rapid advancement of knowledge about the mechanisms of action of ionizing radiation in biological systems. Because NIH training grants support research training in such a wide range of fields including biophysics, radiobiology, radiation chemistry and physics, radiology, and epidemiology, specific identification of training directly related to sources and effects of radiation is not feasible. Training programs in these and many other fields are a major factor in expanding the supply of well-trained, well-qualified scientists for work on a broad spectrum of problems relating to the sources and effects of radiation.

5o. The *Bureau of State Services*, as one of the bureaus of the Public Health Service, has the responsibility for adapting basic research to the use of the States. It also must supply operations research, develop information in areas that are not now being adequately studied, and evaluate the effect of radiation upon the total population of the Nation. Its responsibilities are predominantly in the field of standards and model code formation. It studies problems of irradiation of the population by X-ray, isotopes, and other sources of radiation, of waste disposal, and makes broad environmental and epidemiological studies. Engineering and medical portions of the radiological health program are now centered in the newly formed *Division of Radiological Health*, as one of the divisions of the Bureau of State Services.

5p. The Bureau of State Services implements special radiological responsibilities of the Surgeon General. The Public Health Service Act (42 U.S.C., ch. 6A) provides broad authority to the Surgeon General which may be utilized in connection with radiation hazards, authorizes the conduct of research, investigations, experiments, demonstrations, and studies. It empowers him to assist States and political subdivisions by means of grants and detail of offices to establish and maintain adequate public health services. The Federal Water Pollution Control Act (33 U.S.C. 466) provides a base for action by the Surgeon General in connection with waterborne radiation hazards. The Air Pollution Research and Technical Assistance Act (42 U.S.C. 1857) authorizes the Surgeon General to prepare or recommend research programs for devising and developing methods for eliminating or reducing air pollution. A mechanism which facilitates close working relationships with State and Territorial health officers is the annual Conference of State and Territorial Health Officers established by the act. Working relationships with health authorities outside the Public Health Service are maintained through the structure of the National Advisory Councils and the National Advisory Committee on Radiation.

5q. The *Division of Radiological Health*, formally organized in 1959, combined the activities of the radiological health programs of two other divisions. It operates laboratories in Washington, D.C., at the Nevada Test Site, the Robert A. Taft Engineering Center at Cincinnati, Ohio, and on special assignment. Three additional laboratories are planned for 1960—in Alabama, Nevada, and Maryland.

5r. The Division of Radiological Health cooperates with other divisions and bureaus within the Public Health Service, with other agencies in the Department of Health, Education, and Welfare, other Government agencies (AEC, NAS–NRC, NBS, etc.), universities and research institutions through conferences and special consultations. The Division works in close cooperation with universities and research institutions on a number of projects. Wherever practicable, the Division attempts to perform its research functions in conjunction with the State and local health department activities.

5s. The Division's research activities are conducted on a continuing basis. They are reviewed periodically, and projects are renewed or initiated annually.

5t. The *Robert A. Taft Sanitary Engineering Center* (Cincinnati, Ohio) is a major research center of the Bureau of State Services. It does research in water and air pollution and other environmental

hazards including radiation research and reactor site surveys. It develops new and improved analytical techniques that can be applied at the level of State and local health departments. The radiological health research activities are coordinated to provide radiological research and analysis facilities for all the divisions sharing the center.

5u. The center provides *training* in radiation research and radiological health, to provide public health workers, and others, information regarding the significance of ionizing radiation, the environmental hazards attendant upon the use of X-rays and radioactive materials, and procedures for protecting against or minimizing such hazards. Such training is given to personnel of the Public Health Service, of State and local health departments, and of other Government agencies and private industries.

5v. Environmental monitoring programs conducted by the Division of Radiological Health are: (1) Offsite radiological safety about the Nevada Test Site, from 1955 until now, to document the environmental exposures of the offsite population; (2) environmental maritime monitoring, along the Maritime Estuaries in the Delaware River area, begun in 1959 and coordinated with the Interstate Commission on the Delaware River Basin to document contamination with respect to nuclear propelled shipping; (3) offsite radiological safety at the Eniwetok Proving Grounds, in 1958, to document any radiation exposures occurring in adjacent populated atolls; (4) activities at the National Reactor Test Site, Idaho, from 1956 to now, performed in conjunction with other concerned agencies to develop techniques in assessing radioactivity contamination problems attendant upon the operation of nuclear plant sites; (5) Radiation Surveillance Network since 1956, consisting of 50 field sampling stations to measure radioactive fallout from the atmosphere.

5w. The *Division of Engineering Services*, formerly the Division of Sanitary Engineering Services, initiated radiation research studies in the early 1950's and gave the technical direction to a number of early projects that are now being carried on by the Division of Radiological Health. The Division still conducts specialized radiation research: (1) the milk and food program is engaged in the radiation surveillance of milk, to determine, by periodic sampling at 10 selected points in the United States, any regional differences or trends in contamination of the Nation's milk supply by radioactive materials from fallout or other sources. During fiscal year 1960 this network will be increased to 70 stations, at least one station in each State. The study will also give information concerning the kinds and amounts of radionuclides occurring in milk and will provide the technical basis on which safeguards might be implemented as necessary in the interest of public health protection; (2) the National Air Sampling Network, comprised of 170 sites, submits aerosol samples biweekly for analysis. In addition, rainfall samples from 30 sites, collected monthly in cooperation with the U.S. Weather Bureau, are analyzed for gross radioactivity.

F. Department of Interior

The Department of the Interior was created by act of Congress in 1849, and has since then acquired additional functions for the management, conservation and development of natural resources. The Department is one of the executive departments of the Federal Govern-

ment, headed by the Secretary of the Interior who reports directly to the President. The Department contains departmental offices and 11 bureaus, services, administrations, etc., of which the *Geological Survey*, *Bureau of Mines* and *Bureau of Commercial Fisheries* (within the Fish and Wildlife Service) conduct research in radiation aspects of the life sciences.

TABLE A.—DEPARTMENT OF THE INTERIOR [1]

BUDGETARY AND MANPOWER DATA

(Fiscal year 1959, obligated)

[Dollars in thousands]

Category	Number of projects	Funds	Man-years	
			Scientific	Supporting
1. Radiation biology:				
USGS	1	[2] ($15.0)	1.0	
BCF	5	102.0 [2] (48.1)	7.0	6.0
3. Environmental radiation:				
USGS	6	667.6 [2] (507.9)	27.8	13.0
5. Radiation protection:				
USGS [1]	19	[2] (450.0)	18.5	4.0
B. Mines [1]	4	78.5 [2] (7.5)	2.5	3.0
6. Agriculture: [1]				
BCF	1	9.0	1.0	.5
8. Radiation detection and Measurement:				
USGS [1]	1	83.1	4.0	2.0
B. Mines [1]	1	82.0	2.0	3.0
Total	38	1,482.2 [2] (1,028.5)	63.8	31.5

[1] Reporting data of Geological Survey (USGS), Bureau of Commercial Fisheries (BCF) in the Fish and Wildlife Service, and Bureau of Mines (B. Mines).
[2] Funds transferred from other Government agencies.

TABLE B.—DEPARTMENT OF THE INTERIOR

ORGANIZATIONAL DATA

Research category	Special comment	Who	Where	When	Why	Relationships
1. Radiation biology	6b, m	6 a, l	6 b, l	6 b, m	6a	6b.
3. Environmental radiation	6c	6a	6c	6d	6a	6 c, d.
5. Radiation protection	6 e, i, j	6a	6j	6e	6 a, i	6 *i*, j.
6. Agriculture	6n	6 1	6n	6n	6n	6n.
8. Radiation detection and measurement.	6 g, l	6a	6g	6h	6 a, l	6h.

6a. The *Geological Survey* (USGS) consists of a headquarters organization, most of which is in Washington, D.C., and a field organization of area offices and their subordinate field offices. The *Geologic Division* has among its responsibilities that of conducting research to develop, interpret and understand geologic principles and processes, in large measure as a basis for discovering and evaluating mineral resources and mineral occurrences, including radioactive materials. The *Water Resources Division* is charged with performing research to improve the scientific basis of investigations and techniques relating to water resources. Both divisions conduct research accordingly for a better understanding of the role of radioactive elements in the environment of living organisms.

6b. Since 1957, USGS, jointly with the National Cancer Institute, has been studying possible relationships between local geologic radiation levels and the incidence of cancer in Washington County, Md. Airborne and ground radioactivity surveys (using instruments and techniques originally developed to advance the study of mineral deposits) determine the distribution of radioactive gas emitters in soil and bedrock, and parallel studies determine the radioactivity of the ground water. Geobotanical studies are made of the principal and trace elements in plants and their host soils.

6c. The USGS, adapting knowledge gained during the study of geologic problems, measures the background radiation of critical areas such as national laboratories and reactor sites by means of airborne monitoring. Two especially instrumented planes are in regular use. Other programs concern the relationship between background radioactivity and geologic and hydrologic features as part of a broad study of nuclear geology, including concentrations of radon and tritium and subsurface distributions of natural radioelements. Work is carried on in the field and in laboratories in Washington and Denver.

6d. The programs have been on a continuing basis for a number of years, some with AEC sponsorship. Regular and special reports go to AEC and PHS.

6e. In 1947 the USGS began studies of the hydrologic and geologic conditions in certain critical areas. The general objective of the program is appraisal of the hydrologic and geologic environments surrounding existing and proposed nuclear facilities in terms of possible consequences of a nuclear accident, and determination of areas in the Nation that from the standpoint of hydrology and geology are suitable for the safe disposal or containment of high-level wastes and the safe dispersal of low-level wastes.

6f. Studies in this field are sponsored by AEC to whom semiannual progress reports, and topical reports as necessary, are made.

6g. Since 1952 the USGS has been designing, building, and testing radiation detection devices. The work is done in the electronics laboratory at Denver, which designs and builds prototype radiation detection instruments that can be used under a wide variation of conditions or for special purposes.

6h. Funding is on a continuing basis from the Survey's direct appropriation. Semiannual reports are made to the AEC, which formerly sponsored the project, and to other agencies as occasion may require.

6i. The *Bureau of Mines* (B. Mines) is composed of a headquarters organization in Washington, D.C., and five regional headquarters, with research centers and laboratories in these regions devoted to investigations on coal, petroleum, and minerals. The Bureau conducts programs designed to promote the conservation and development of mineral resources and to promote safety and healthful working conditions in the mineral industries. Within these programs, the Bureau has been involved to some degree in research on the beneficial and harmful effects of radiation within the categories of radiation protection; radiation detection and measurement; education, training and information. The last category is, however, an integral part of the Bureau's work, and funds are not budgeted specifically for training purposes.

6j. In 1959, jointly with AEC, the B. Mines began studies in Utah to minimize pollution of the environment by uranium mill wastes.

At Pittsburgh, tests are being made to determine how masks may be converted to protect workers against airborne radioactive particulates. At Denver, the Bureau has a joint program with PHS to evaluate and control radiation hazards to miners in uranium and thorium mining operations. At Albany, Oreg., the Bureau is studying with AEC the radiation hazards in melting naturally radioactive metals and alloys. Reports go regularly to AEC and PHS, and contacts are maintained with health officials of the interested States.

6k. At Bartlesville, Okla., the Bureau developed incidentally to other problems, portable radiation detection equipment suitable for measuring radioactivity in underground fluid movement, in rivers, streams, etc., and for continuous monitoring of drinking water supplies.

6l. The *Bureau of Commercial Fisheries* (BCF) (within the Fish and Wildlife Service) has a headquarters office in Washington, D.C., five regional and two area offices. Its objective is to maintain the welfare of commercial fisheries in the Nation by conducting research, investigations and various service studies. It conducts radiation research concerned with fishery biology at its *Biological Laboratory, Beaufort, N.C.*, where it has pioneered in studies to determine the effects of radioactive substances on aquatic organisms and the extent and means by which these substances may be concentrated in plants and animals and transmitted to man. The Beaufort laboratory is staffed by seven scientists.

6m. Fishery radiobiological studies were begun jointly with AEC in 1948, to determine the hazards to man from accumulation of radioactive materials by fishery organisms, and to determine the damaging action of radiations upon fish, shellfish, their foods and environment. The Bureau collaborated with the AEC on radioactive waste disposal tests conducted off Boston during 1959, and is also taking part in plans for further and more extensive tests in the Gulf of Mexico in the summer of 1960.

6n. The Bureau conducts research on the use of low-intensity pasteurizing doses of radiation to extend the shelf life of fishery products. These studies are conducted at the Bureau's *Fishery Technological Laboratories in Seattle, Wash., College Park, Md.*, and *Gloucester, Mass.* The project is presently inactive owing to the completion of the present phases of the work.

G. National Academy of Sciences—National Research Council

The National Academy of Sciences was established by act of Congress in 1863. In 1916, at the President's request, the Academy organized the National Research Council as a measure of national preparedness, and perpetuated it in 1919, also at the President's request. Although not a governmental agency, the Academy enjoys close relations with the Federal Government. The Academy-Research Council does not maintain laboratories of its own, but seeks to stimulate and support investigations of broad research problems through a wide variety of means, such as conferences, technical committees, surveys, publications, and the administration of public and private funds for research projects and fellowships. In the field of radiobiology, it operates the Atomic Bomb Casualty Commission in Japan for the Atomic Energy Commission.

TABLE A.—NATIONAL ACADEMY OF SCIENCES

BUDGETARY AND MANPOWER DATA

(Fiscal year 1959, obligated)

[Dollars in thousands]

Category	Number of projects	Funds	Man-years	
			Scientific	Supporting
1. Radiation biology	8	$319.0	16.0	115
2. Radiation genetics	3	133.0	10.5	74
3. Environmental radiation	3	22.6	1.5	11
5. Radiation protection	2	99.9	5.0	36
7. Medical application	16	1,300.3	41.0	204
8. Radiation detection and measurement	1	51.6	2.0	14
Total ABCC [1]	33	[2] (1,926.4)	[3] 76.0	[4] 544
9. Education, training and information	21	(5)	(5)	(5)

[1] Atomic Bomb Casualty Commission. Its program comprises 33 projects integrated into a single unified program.
[2] Funds shown in parentheses received under contract with AEC.
[3] 24 Americans, 52 Japanese.
[4] 38 Americans, 506 Japanese.
[5] Estimates would have little meaning. The Committees identified in table B have a total membership of 167 scientists and physicians.

TABLE B.—NATIONAL ACADEMY OF SCIENCES

ORGANIZATIONAL DATA

Research category	Special comment on research categories	Who	Where	When	Why	Relationships
ABCC program	7a	7c	7d	7e	7f	7g
Information and advisory	7b	7h	7i	7j	7k	7l

7a. *The Atomic Bomb Casualty Commission.* A field installation of the National Academy of Sciences operated under contract with the Atomic Energy Commission.

7b. *Advisory Committees of the Academy-Research Council* concerned wholly or in significant degree with the evaluation of the relation of radiation to human welfare.

(1) The BEAR Committees (the Biological Effects of Atomic Radiation):

Committee on Genetic Effects of Atomic Radiation.

Committee on Pathological Effects of Atomic Radiation.

Committee on Meteorological Aspects of the Effects of Atomic Radiation.

Committee on the Effects of Atomic Radiation on Oceanography and Fisheries.

Committee on Effects of Atomic Radiation on Agriculture and Food Supplies.

Committee on Disposal and Dispersal of Radioactive Wastes.

(2) Committee on Radiology, Division of Medical Sciences, NAS–NRC.

(3) Committee on Nutrition, Advisory Board, Quartermaster Research and Development.

(4) Subcommittee on Radiobiology, Division of Physical Sciences, NAS–NRC.

(5) National Committees of International Unions:

National Committee on the International Union Against Cancer.

National Committee for the International Union of Physiological Sciences.

National Committee on the International Union of Biological Sciences.

National Committee on the International Union of Nutritional Sciences.

National Committee on the International Union of Biochemistry.

National Committee on the International Union of Pure and Applied Physics.

National Committee on the International Union of Pure and Applied Chemistry.

National Committee for the International Inter-Society Committee on Pathology.

7c. *Division of Medical Sciences*, NAS–NRC, under contract with AEC. ABCC reports to the AEC through the Chairman, Division of Medical Sciences.

7d. *Hiroshima and Nagasaki, Japan.* The facilities include a clinic and supporting laboratories and services (diagnostic ward, clinical, pathological, radiological, and isotope laboratories, IBM machines, printing, photographic, and electrical shops, and a motor pool).

7e. Has been in operation continuously since 1947 and is projected into the indefinite future.

7f. The project was undertaken under a directive of President Harry S. Truman (November 18, 1946). It consists in a comprehensive medical and pathological followup (mortality, morbidity, pathology, genetics, and ageing) of the only large population of human beings that has been exposed to a significant instantaneous dose of atomic radiation.

7g. The contractual relationships of the Academy with respect to ABCC are with the Atomic Energy Commission. In the staffing and scientific direction the Academy has cooperative agreements with the Ministry of Health and Welfare of Japan and with local Japanese authorities and institutions. In the United States it has the cooperation of many institutions and agencies in securing staff for service with ABCC. The chief of these are the Public Health Service, the Armed Forces, the Atomic Energy Commission, the Medical Schools of Yale University and of the University of California (UCLA), and the Oak Ridge National Laboratory. The scientific results of the project are disseminated as reports through the Atomic Energy Commission in the United States and, in Japan, through the National Institute of Health of Japan. Many of the results are also published in the scientific literature of the United States and Japan.

7h. These committees report to the President of the Academy directly or through the Chairmen of one or other of the Divisions of the NAS–NRC.

7i. The offices of the committees are in the National Academy of Sciences, Washington, D.C.

7j. These committees were established at various dates in the period 1946 to 1955.

7k. The sponsorship of Committees listed under 7b is as follows:

The BEAR Committees: The Rockefeller Foundation.

The Committee on Radiology: The Picker Foundation.

The Committee on Nutrition: The Quartermaster, U.S. Army.

The Subcommittee on Radiobiology: The National Science Foundation.

The National Committees for International Unions: The Scientific Societies of the United States with financial support from various Government and private agencies.

7l. The opinions and special studies of these committees are released as reports of the National Academy of Sciences which are distributed to the sponsoring agencies and interested Government agencies.

H. National Science Foundation

The National Science Foundation was established by act of Congress in 1950, for the purpose among other things of initiating and supporting basic scientific research, including the life sciences. Its chief executive is the Director, appointed by the President. He is advised by the National Science Board, consisting of 24 members appointed by the President, to provide representation of the views of the Nation's scientific leaders. The Foundation is organized into seven divisions and offices, of which the *Division of Biological and Medical Sciences* and the *Division of Scientific Personnel and Education* support a limited number of projects in radiation biology.

Table A.—National Science Foundation

BUDGETARY AND MANPOWER DATA

(Fiscal year 1959, obligated)

[Dollars in thousands]

Research category	Number of projects	Funds	Man-years	
			Scientific	Supporting
1. Radiation biology	2	$20.5	0	1
2. Radiation genetics	12	75.9	[1] 6	7
9. Education, training, and information:				
Symposia	2	20.3		
Individual travel	2	2.0		
Summer institutes: [2]				
College teachers	2	39.2		
High school teachers	17	318.6		
Total	37	476.5	6	8

[1] Man-years indicated are those supported by NSF grants. Other than summer salary, the time of the principal investigator is not included. If all of the time devoted to the projects were included, the man-years would be more than doubled.

[2] NSF provided support only for stipends, travel, and dependent allowances for the individual teachers participating in the Institutes; operating funds were provided by AEC. Man-years devoted to instruction are not available.

TABLE B.—NATIONAL SCIENCE FOUNDATION

ORGANIZATIONAL DATA

Research category	Special comment	Who	Where	When	Why	Relationships
1 Radiation biology	8a	8a	8a	8a	8 a, e	8f.
2. Radiation genetics	8b	8c	8c	8d	8e	8f.
4 Education, training, and information.	8 g, j	8 g, j	8 g, j	8 g, i, j	8 g, j	8 g, h, j.

8a. This includes one regular research project at a college; the program is conducted on a regular basis and has been supported by NSF since October 1957. The second project is the purchase of an X-ray machine to be used in a variety of fields of biological research at California Institute of Technology.

8b. The radiation genetics projects include studies of frequency of mutation produced by varying levels of radiation, conditions (nutritional, metabolic, atmospheric) which are necessary for the production of mutations, types of genetic effects produced and the action of the genes which have been caused to mutate by irradiation, and the production of genetic variability within a group of animals by means of irradiation induced mutation.

8c. The principal investigators are all investigators of faculty status in colleges or universities or private research institutes; 10 in 9 American universities or colleges, 1 in an American private research foundation, and 1 in a Canadian university.

8d. Most of these projects are of several years standing. In one case NSF support has been continuous since February 1952; the others have been supported for lesser periods of time, including four in which NSF support began during the current fiscal year. The overall program of support of radiation genetics is a continuing part of the support of genetic research by NSF.

8e. Since radiation biology, including genetics, involves basic biological research, support of it is essential to the mission of NSF in the support of basic research.

8f. In determining support of individual research projects, the possibility and appropriateness of other sources of support are always considered. Information regarding other sources of support is obtained from the investigator, from Biological Sciences Information Exchange and from other agencies which might provide support, in particular from the National Institutes of Health with whom we have a close working relationship. Through these same means, it is possible to determine whether a particular project is being duplicated elsewhere. Our relationships with the colleges and universities at which the projects are carried out are established through the investigators themselves, through advisory panels of scientists, and through visits of staff to the institutions.

8g. During fiscal year 1959, NSF supported, jointly with AEC, two international symposia on radiation effects. One of these was held in Venice, Italy, and funds were provided for travel of U.S. scientists to Italy. The other was held at the University of Minnesota and funds were provided for general support of the symposium, including travel of foreign scientists to the United States. This

provided opportunities for both formal and informal exchange of information between U.S. and foreign scientists. In two cases, where general support was not provided, individual scientists were provided travel funds to attend symposia in Germany and in Australia.

8h. Dissemination of information was encouraged by partial support of publication costs of the proceedings of the symposium held in the United States.

8i. Two of the conferences for which general support or individual travel was provided were annual events; the other two were specialized symposia which were considered as single events and not as annual congresses.

8j. The radiation biology portion of the summer institutes program is a cooperative project with AEC, providing training for high school and college teachers in modern radiation biology. The institutes were held in 18 American colleges and universities, all in the continental United States, except one at the University of Puerto Rico. The program is a continuing one, though individual institutes apply each year for support. The program will be expanded in fiscal year 1960 to include approximately five institutes for college teachers and 21 for high school teachers and three or four institutes on isotope technology will be added. All of these programs are cosponsored by AEC.

I. Office of Civil and Defense Mobilization

The Office of Civil and Defense Mobilization was established in the Executive Office of the President in 1958, for the purpose of centralizing authority for nonmilitary defense functions in a single agency. The missions of the Office (formerly Federal Civil Defense Administration and Office of Defense Mobilization) are: protection of life and property, and through nonmilitary action to prevent, minimize, repair and recover from injury and damage; mobilization and management of resources and production. Authority to conduct appropriate research activities is set forth in the Federal Civil Defense Act and the Defense Production Act. National headquarters is in Washington, D.C., under a director who advises and acts on behalf of the President in coordinating civil defense and defense mobilization activities. Operational headquarters is in Battle Creek, Mich.

Table A.—Office of Civil and Defense Mobilization

Budgetary and manpower data

(Fiscal year 1959, obligated)

[Dollars in thousands]

Category	Number of projects	Funds	Man-years	
			Scientific	Supporting
1. Radiation biology	3	$285.0	8.5	10.0
3. Environmental radiation	3	515.0	16.0	5.0
5. Radiation protection	2	352.0	8.0	3.0
8. Radiation detection and measurement	2	50.3	.8	1.8
Total	10	1,202.3	33.3	19.8

TABLE B.—OFFICE OF CIVIL AND DEFENSE MOBILIZATION

ORGANIZATIONAL DATA

Category	Special comment	Who	Where	When	Why	Relationship
1. Radiation biology	9f	9a	9 a, f, g	9 f, g	9d	9 b, c, e.
3. Environmental radiation	9h	9a	9 a, l	9l	9d	9 b, c, e.
5. Radiation protection	9j	9a	9 a, k	9k	9d	9 b, c, e.
8. Radiation detection and measurement.	9l	9a	9 a, m	9m	9d	9 b, c, e, m.

9a. The segment of OCDM responsible for research uses the title RESEARCH. It is under a director located in Washington, D.C., but the staff is located primarily in Battle Creek, Mich., with liaison personnel in Washington and Santa Rosa, Calif. Radiation effects in life sciences is conducted by the *Physical Sciences Division*, *Biophysical and Medical Sciences Division*, and the *Engineering Division*.

9b. RESEARCH has a number of advisory committees and consultants, including the NAS–NRC Civil Defense Scientific Advisory Committee, and an ad hoc NAS Subcommittee on Radiation Shielding composed of technical personnel from a number of governmental agencies. A Civil Defense Coordinating Board, representing 17 Federal agencies, serves as a central clearinghouse for exchange and coordination of ideas and plans. Every effort is made to insure maximum use of research results developed by Government and industrial laboratories and by educational institutions, and reports are routinely exchanged.

9c. OCDM maintains cognizance of research in foreign countries through participation in symposia, and by the exchange of personnel visits with foreign laboratories.

9d. OCDM research has the objective of determining how best to reduce the effects of direct and indirect exposure of people to nuclear radiation. The basic and interrelated elements of fallout shelter, medical measures, monitoring and radiological reclamation of urban and agricultural areas are investigated to achieve effective radiological defense.

9e. Findings and reports are routinely distributed to all contractors, consultants, advisory groups, Federal agencies, civil defense groups, technical libraries, NATO and other organizations. Reports from governmental and nongovernmental agencies are routinely received. Annual meetings on instrumentation are held with agency and industrial personnel.

9f. Studies in radiation biology are sponsored as part of the total program to develop means for treating or protecting the civilian population against the effects of large-scale nuclear irradiation. The exposures of interest are those which produce acute symptoms of radiation injury and which are lethal for less than 10 percent of the subjects exposed. Correlation is explored between biochemical, physiological and histological changes in postirradiated animals, and reduction in lifespan.

9g. The studies are conducted by universities and by the Naval Radiological Defense Laboratory, on a continuing basis.

9h. Studies on environmental radiation assist the development of procedures for decontaminating and rehabilitating essential facilities

and residential and agricultural areas, following a major nuclear incident. The program also includes development of methods for improving predictions of radioactive deposition as a function of climatological and meteorological data.

9i. OCDM has sponsored climatological studies by the U.S. Weather Bureau for several years, particularly during the International Geophysical Year. It is sponsoring studies by the Naval Radiological Defense Laboratory on a continuing basis, on problems of decontamination.

9j. This research gives information on the amount of shielding and protection against radiation that is afforded by structures in various configurations. An electronic computer is used to solve a variety of complex situations which might arise as a result of nuclear incidences of different kinds.

9k. These studies are carried out mainly by the National Bureau of Standards, on a continuing basis.

9l. Simple, inexpensive and reliable instruments, suitable for general use in measuring radiation dose, are under development. Prototype instruments suitable for measuring ground level dose rates with low flying planes have been designed. Instruments for identifying hazardous isotopes in contaminated water are being developed. These types of instruments are required for use in radiological and reclamation operations should there be widespread contamination from some type of nuclear incident.

9m. The development projects are being done by contract with private industrial laboratories and manufacturers of radiation detection equipment. They are closely coordinated with DOD and AEC, and some aerial survey instruments are being developed by AEC contractors. This is a continuing OCDM program, in which a half dozen additional projects originally scheduled for fiscal year 1959 have been begun in fiscal year 1960.

J. U.S. Veterans' Administration

The Veterans' Administration was established as an independent agency in 1930 by consolidation of the then existing several different agencies concerned with various aspects of veterans' affairs. There are three major operating departments under an Administrator of Veterans' Affairs, who has a staff in addition to the three departments.

The Department of Medicine and Surgery was established in 1946 by Public Law 293, 79th Congress. The Department functions under a Chief Medical Director who is directly responsible to the Administrator of Veterans' Affairs. The Assistant Chief Medical Director for Research and Education in Medicine is responsible for the establishment and conduct of programs of research and education. These two programs, research under the Director, Research Service, and education under the Director, Education Service, work in close association though from separate budgets.

The medical research program is largely decentralized. Research activities take place at VA hospitals which are widely distributed throughout the Nation. The major functions of Central Office officials are in the areas of coordination, support and control.

TABLE A.—U.S. VETERANS' ADMINISTRATION

BUDGETARY AND MANPOWER DATA

(Fiscal year 1959, obligated)

[Dollars in thousands]

Research category	Number of projects	Funds	Man-years	
			Scientific	Supporting
1. Radiation biology	38	170	15	23
3. Environmental radiation	2	10	1	1
5. Radiation protection	17	75	7	10
7. Medical applications	146	650	60	90
8. Radiation detection and measurement	29	130	12	17
Total	232	1,035	95	141

TABLE B.—U.S. VETERANS' ADMINISTRATION

ORGANIZATIONAL DATA

Research category	Special comment	Who	Where	When	Why	Relationships
1. Radiation biology	10a, b	10b, g	10h	10i	10j	10k.
3. Environmental radiation	10a, c	10g	10h	10i	10j	10k.
5. Radiation protection	10a, d	10g	10h	10i	10j	10k.
7. Medical applications	10a, e	10g	10h	10i	10j	10k.
8. Radiation detection and measurement	10a, f	10g	10h	10i	10j	10k.
9. Education, training, and information.	10l					

10a. The dollar and man-year figures given in table A were not available as data within a detailed cost-accounting system. However, figures were available for total dollars and man-years expended upon the total list of projects at a particular VA hospital research program. From these figures averages were computed and used, with all available specific data, as the basis for the tabulations presented. Where the number of projects in a reportable category is small, as in the case of the two projects in category 3, environmental radiation, conducted one each at two VA hospitals, the significance of the figures given is open to question. However, the figures for totals are believed to be acceptably accurate.

10b. The 38 projects in radiation biology were conducted in 17 VA hospitals by investigators who become interested in special problems of their own within that category. There is no plan to organize a comprehensive research effort in radiation biology. Characteristic of VA medical research, in 30 of these 38 projects the principal investigator was a physician whose primary concern is the welfare of his patients and whose research interests are closely related to the clinical problems presented by those patients. In an additional two projects the principal investigator was a physician who has become a career investigator in cancer and leukemia and no longer carries patient-care responsibilities. In the remaining six projects the principal investigator was a Ph. D. in three instances, a D.D.S. in two, and in one instance a biologist with M.S. degree and special training in radioisotope technology.

10c. The two projects in environmental radiation represent individual approaches to the search for improved methods of separating, identifying and measuring the fission products in a fallout field.

10d. The 17 projects in radiation protection were conducted in 11 hospitals. These projects run the gamut from mechanical aids and electronic data processing techniques for maintenance of optimal field sizes and beam orientations during diagnostic and therapeutic radiation procedures, to brilliant successes in storing human bone marrow grafts at minus 79 degrees centigrade for up to two years without loss of viability, proved by subsequent successful reimplantation in the original human donor.

10e. Medical applications, particularly the use of radioisotopes in diagnosis and treatment, are increasing steadily and rapidly. The 146 projects listed in this category in table A were conducted at 41 VA hospitals. In compiling this list, hundreds of projects were excluded because they used radioisotopes as tools or tracers rather than as direct factors in diagnosis or treatment of disease.

10f. The 29 projects in radiation detection and measurement listed in table A were conducted at 17 VA hospitals. Many of the project reports in this category describe instruments and methods that reveal extraordinary ingenuity on the part of the investigator. This is particularly true of the newer methods of measuring blood flow in hitherto inaccessible segments of the circulation such as the coronary arteries.

10g. At each hospital with an established research program there is a local Committee on Research and Education in Medicine. This committee is comprised of the physicians and other scientists who are most sophisticated in research matters and is charged with the administration of the research program in the hospital. Members of the staff wishing to do research present their projects as proposals to this committee, in competition with other staff members for funds and space. Forty-one of the forty-four hospitals, at which the projects listed in table A were conducted, are affiliated with medical schools. In affiliated hospitals two members of the medical school faculty are appointed by the dean to the Research and Education Committee. The pivotal body through which the VA hospital and the medical school are integrated is the dean's committee, composed of senior members of the medical school faculty. They are nominated by the dean but appointed to the dean's committee by the Chief Medical Director of the VA. Communication between the research program in the hospital and the research service staff at VA central office in Washington is maintained through the Assistant Director of Professional Services for Research on the hospital staff. He implements the decisions of the Research and Education Committee, acts as the committee's secretary and sees that minutes of the committee's meetings and actions are sent through the hospital manager's Office to central Office.

10h. During the period covered by this compendium there were established research programs, with laboratories equipped and staffed for medical research, at 128 VA hospitals. At 60 of these hospitals radioisotope laboratories had also been established. At one of these hospitals (Omaho) the Radioisotope Service operates a nuclear reactor of a type designed especially for use in medical research. In two

others (Boston and Los Angeles) the facilities of the Radioisotope Service include low-level total-body counters. The 232 research projects reported in table A were conducted at 44 VA hospitals. Forty-three of these had radioisotope laboratories in addition to general medical research programs.

10i. VA did some early pioneering in radioisotopes. Eight laboratories were equipped for this work in 1948. By the end of fiscal 1949, twelve VA hospitals had established radioisotope services. By the end of fiscal 1959 there were 60 such. New ones will continue to be established as the need is demonstrated and funds become available. The program is a continuing one. The installation of the nuclear reactor in the VA hospital at Omaha in fiscal 1959 will doubtless be followed by other, similar enlargements in the scope of the radioisotope and radiobiology features of the research program. The total research program is growing and studies of radiation are also on the increase.

10j. It is now recognized that, by including vigorous programs of research education in a medical care system like that of the Veterans' Administration, it is possible to achieve a remarkable improvement in the quality of the medical care. The predominant objectives of the VA research program are: (1) maintenence of high-quality patient care in VA hospitals and clinics; (2) continuing study of health problems having greatest importance to the veteran population; (3) fulfillment of the obligation to make contributions to the general body of medical knowledge; (4) recruitment and retention of high-quality medical and other scientific personnel; (5) research in the basic sciences consistent with support of the major medical objectives. The inclusion of an appropriate amount of research in several of the categories covered by this compendium was to be expected since VA is notably up to date in its orientation toward radiation and its potentialities for good and bad.

10k. Active cooperative relationships are maintained with the National Academy of Sciences-National Research Council, the Armed Forces Institute of Pathology, the Bio-Sciences Information Exchange of the Smithsonian Institution, the Bureau of Standards, the Forest Products Laboratory of the Department of Agriculture, and the National Institutes of Health. VA supports extramural research at the University of Colorado, Columbia University, and Johns Hopkins University. By far the most important relationship of the VA is with the medical schools of the Nation. Eighty-nine of VA's 170 hospitals are affiliated with medical schools. The impact of these medical school affiliations upon the research program has been especially noteworthy. The enthusiastic collaboration between VA investigators and medical school faculty members, the free exchange of ideas and advice, and the reciprocal availability of laboratory facilities and equipment have exemplified the highest ideals of medicine and have established a precedent for cooperative research on a scale never before possible.

10 l. The VA medical research program and educational program, working together in close cooperation, have much to offer in the way of opportunities for training and education. Residents in internal medicine, radiology and pathology are detailed to other VA hospitals, or to universities, for special training courses of various kinds includ-

ing radioisotope technology. They are also sent to Oak Ridge for training courses in physics, radiobiology and radioisotope technology. VA hospital staff physicians are offered the same opportunities. An excellent school is maintained at VA hospital, Omaha, for training in nuclear reactor technology and medical applications. At 31 of the VA hospitals with radioisotope laboratories, training has been provided for several hundred radiological defense monitors, for possible use in nuclear disaster or warfare.

Part 2

NONGOVERNMENTAL GRANTING AGENCIES

Research projects in five of the nine categories listed on page 15 are supported by U.S. professional societies, foundations and memorial funds. Information on the grants made by these societies is registered annually with Bio-Sciences Information Exchange, Smithsonian Institution, and includes the names of the granting agency and grantee, title of project, a 200-word summary of its purpose and accomplishments, and the amount of the grant. These data, with the exception of the individual amounts of funding, are readily available upon request for both governmental and nongovernmental granting agencies.

TABLE A.—U.S. NONGOVERNMENTAL GRANTING AGENCIES

BUDGETARY DATA [1]

[Dollars in thousands]

Category	Number of projects	Funds
1. Radiation biology:		
United States	16	$240.6
Foreign	6	50.4
2. Radiation genetics:		
United States	6	88.1
Foreign	2	19.9
3. Environmental radiation:		
United States	1	3.0
Foreign	1	2.1
6. Agriculture:		
United States	1	5.0
Foreign	1	.5
7. Medical applications:		
United States	14	114.9
Foreign	2	15.5
Total	50	540.0

[1] Grants awarded during the Government fiscal year 1959.

The 16 granting agencies participating in the support of research projects in radiation as applied to the life sciences are:

American Cancer Society.
AMA Committee on Research.
Childs Memorial Fund for Medical Research.
Damon Runyon Fund.
Donner Foundation.
Guggenheim Foundation.
Hartford Foundation.
Hematology Research Foundation.
James Picker Foundation.
Leukemia Society.
National Council to Combat Blindness.
Orthopaedic Research and Educational Foundation.
Pfeiffer Research Foundation.
Population Council.
Rockefeller Foundation.
United Cerebral Palsy Foundation.

Part 2

NONGOVERNMENTAL GRANTING AGENCIES

Research projects in each of the nine categories listed on page 67 are supported by U.S. professional societies, foundations and memorial funds. Information on the grants made by these societies is registered annually with Bio-Sciences Information Exchange, Smithsonian Institution, and includes the names of the granting agency and grantee, title of project, a 200-word summary of its purpose and accomplishments, and the amount of the grant. These data, with the exception of the individual amounts of funding, are readily available upon request for both governmental and nongovernmental granting agencies.

TABLE A.—U.S. NONGOVERNMENTAL GRANTING AGENCIES

RUDIMENTARY DATA [1]

[Dollars in thousands]

Category	Number of projects	Funds
1. Radiation biology:		
United States	16	$349.6
Foreign	6	20.4
2. Radiation genetics:		
United States	6	68.1
Foreign	2	19.9
3. Environmental radiation:		
United States	1	2.0
Foreign	1	2.1
4. Agriculture:		
United States	1	3.0
Foreign	1	.5
7. Medical applications:		
United States	14	114.0
Foreign	2	15.2
Total	50	580.0

[1] Grants awarded during the Government fiscal year 1959.

The 16 granting agencies participating in the support of research projects in radiation as applied to the life sciences are:

American Cancer Society.
AMA Committee on Research.
Childs Memorial Fund for Medical Research.
Damon Runyon Fund.
Donner Foundation.
Guggenheim Foundation.
Hartford Foundation.
Hematology Research Foundation.
James Picker Foundation.
Leukemia Society.
National Council to Combat Blindness.
Orthopaedic Research and Educational Foundation.
Pfeiffer Research Foundation.
Population Council.
Rockefeller Foundation.
United Cerebral Palsy Foundation.

Part 3

OTHER NATIONS—EUROPE, ASIA, AND LATIN AMERICA

A. Argentina

National Commission for Atomic Energy (CNEA) maintains a permanent headquarters building in Buenos Aires, with offices, laboratories, and rooms for lectures, training, and meetings. Its Department of Biology and Medicine is conducting studies on effects of radiation on biological materials. CNEA also contracts for radiobiology research with hospitals, clinics and medical institutes. The Instituto de Fitotecnica of the Argentine Ministry of Agriculture, using Cs–137 and Co–60 sources, does research on plant and seed materials. In 1957–58, Argentina imported nearly 30,000 millicuries of radioisotopes, plus three cobalt-60 teletherapy units comprising 3,500,000 millicuries. Nearly all of these radioisotopes were for use in medical diagnosis and therapy, and in biological and medical research.

Radiation Biology Research in Argentina

BUDGETARY AND MANPOWER DATA, 1959

[Dollars in thousands]

Category	Number of projects	Funds	Scientific man-years	Supporting man-years
1. Radiation biology	2	$20	6	14
2. Radiation genetics	2	8	2	4
3. Environmental radiation	1	70	4	6
6. Agriculture	4	12	5	8
7. Medical application	1	10	1	1
9. Education, training, and information	1	10	2	2
Total	11	130	20	35

1. *Radiation biology.*—Both projects are conducted by the Argentine AEC (Comisión Nacional de Energiá Atómica) Department of Biology and Medicine. One project consists of whole body irradiation of pure-strain rodents, in order to study effect on life processes under various degrees of radiation; the other project is a study of radiation on the cultivated tissues containing cells from human cancers. Both studies have been going on for about a year, and are expected to continue another year. In the second project tissues are obtained from cooperating government hospitals. Laboratories are of modest, fairly adequate type, with nothing special or unique in the way of equipment, except that rodent quarters are air-conditioned, located at the main headquarters of the Comisión in Buenos Aires. Since the Comisión is charged by public statute with studying the effects of nuclear energy, these projects, and all others mentioned below which are being performed by the Comisión are directly in line with statutory requirements.

2. *Radiation genetics.*—Both projects are conducted by the Biology and Medicine Department of Argentine AEC. One consists of the study of mutations produced in fruitflies by radiation of oocytes and oogonia of same; and the other of study of cytological effects of irradiating artificially produced tumors of the Drosophila. Two-year study. Ordinary lab equipment.

3. *Environmental radiation.*—At the Argentine AEC the Health Physics Department is taking counts of Sr–90 in soil, air rain water and edible plants. The purpose of this study is to keep the local authorities informed as to the presence of fallout.

6. *Agriculture.*—The first three are done in Department of Biology and Medicine, Argentine AEC.

(a) Irradiation of seeds, cuttings, pollen, etc., of various common cereals in order to study effect on further growth of plant, and mutants produced.

(b) Study of mutant effects due to irradiation of micro-organisms which cause various plant diseases.

(c) Study of factors which increase P–32 uptake by plants. Two-year study. Cooperation with Faculty of Agronomy of University of Buenos Aires.

(d) This project, a study of mutations caused by irradiation of seeds of cereals and ornamental plants, is performed at the Plant Technology Institute of the Argentine Ministry of Agriculture at its field station at Castelar, Province of Buenos Aires.

The purpose of all four studies is to improve Argentine plant strains and plant resistance to disease. The laboratory equipment is not unique in any respect, except for the use of a 1-curie cesium 137 source at the Institute (in addition to high voltage X-rays), which is the only use of such a source for irradiation of plant or animal substances in Argentina.

7. *Medical applications.*—Twelve institutions use 1,600 millicuries of I–131 in studying the therapy of hyperthyroidism and cancer of the thyroid. The main project is the study of clinical effects of I–131 on thyroid tissue by use of the electron microscope, at the Medical School in Buenos Aires. Nine institutions study the treatment of polycythemia, leukemia, and bone metastases with phosphorous-32. There are various projects which use radioisotopes as tracers: 18 institutions use iodine-131 to study thyroid function, 3 use cobalt 60 to diagnose peranemia, 3 use chromium 51 to study red corpuscle survival.

9. *Education, training and information.*—The Health Physics Department of the Argentine AEC gives regular courses 2–4 times yearly to physicians and laboratory workers, in protection against radiation used in medical and laboratory practice. The Department of Radiophysics, University of Buenos Aires Medical School gives a course in the use of radioisotopes as a research tool in medical research, and a more general course gives detailed laboratory instruction on radioisotope use to 1,500 medical students.

B. Brazil

The National Nuclear Energy Commission (CNEN) promotes development of atomic energy in Brazil for research in biological sciences and in medical therapy and diagnosis, among other researches. Studies are conducted at: (1) the Instituto de Fisica Atómica, University of São Paulo, on radiobiology; (2) the Isotope Laboratory, School of Medicine, University of São Paulo, on diagnosis and therapy, training physicians and technicians in the medical uses of radioisotopes and research in the use of isotopes in medicine in extensive, well-equipped medical isotope laboratories; (3) the Instituto de Pesquisas Radioactivas, University of Minas Gerais, in the use of radioisotopes in biological and medical research. In addition, Brazil has several hospitals with radioisotope laboratories and there are a number of cobalt teletherapy units in use.

There are two geographical areas in Brazil with relatively high background radiation intensities, one monazite area which averages a dose of 0.5 rad per year to about 50,000 inhabitants, and one a mineralized volcanic area which averages about 1.6 rad per year to a sparse population. With the thought that such areas and populations might provide material for studying the effects of chronic, low-level exposures, the Brazilian Society of Genetics has created a Commission on Human Genetics for the purposes of developing a plan of epidemiological research in Brazil and to enhance the teaching of genetics in the School of Medicine. The preliminary plan is being discussed, and hopefully will be implemented soon with Brazilian and foreign assistance.

C. Canada

In Canada, radiation research in the life sciences is supported by the Federal Government and by two privately controlled cancer funds, with the following expenditures in fiscal year 1959–60:

AEC	Atomic Energy of Canada, Ltd	$685,000
DNHW	Department of National Health and Welfare	240,695
DRBC	Defense Research Board of Canada (extramural grants only)	57,575
NRCC	National Research Council of Canada	9,800
CDA	Canadian Department of Agriculture	60,000
NCIC	National Cancer Institute of Canada	162,200
OCTRF	Ontario Cancer Treatment and Research Foundation	56,700
	Total	1,272,000

Radiation Biology Research in Canada

Fiscal, manpower, and organizational data

[Dollars in thousands]

Category	Number of projects	Funds	Professional man-years	Who	Where
1. Radiation biology	6	$157.0	5.4	AEC	a.
	1	15.3	2.0	DNHW	i.
	2	6.0	1.3	NCIC	g, l.
	13	135.0	15.0	NCIC	p.
	6	42.8	4.0	DRBC	b, h, k, r.
	4	11.7	1.9	OCTRF	g, q.
	1	2.3		NRCC	h.
2. Radiation genetics	3	38.0	1.8	AEC, NRCC	a.
	1	4.2	.5	NCIC	l.
	1			DRBC	p.
3. Environmental radiation	4	190.0	6.1	AEC	a.
	1	80.0	2.0	DNHW	c.
4. Radiation toxicology	1	20.0	1.0	AEC	a.
5. Radiation protection	5	125.0	3.7	AEC	a.
	1			NCIC	l.
	2	19.3	3.0	DRBC, NRCC	h, m.
	1	3.6	.3	DNHW, NRCC	c.
6. Agriculture	3	60.0	3.0	CDA	d, e, f.
7. Medical applications	3	18.2	3.3	DNHW	c, o, u.
	1			NCIC	p.
	5	45.0	4.5	OCTRF	n, p.
8. Radiation detection and measurement.	6	158.0	3.8	AEC	a.
	4	123.6	3.5	DNHW	c, h, v.
	5	17.0	5.0	NCIC	a, j, p.
	1			DRBC	b.
	1			OCTRF	p.
Total	82	1,272.0	71.1		

The research is conducted in the following laboratories:

GOVERNMENT

a. Atomic Energy of Canada, Ltd. (Chalk River, Ontario).
b. Defense Research Chemical Labs (Ottawa).
c. Department of National Health and Welfare (Ottawa).
d. Canadian Department of Agriculture, Soils Research Institute (Ottawa).
e. Canadian Department of Agriculture, Animal Research Institute (Ottawa).
f. Canadian Department of Agriculture, Summerland Experiment Station, (Summerland, British Columbia).

UNIVERSITIES

g. Western Ontario (London).
h. Toronto (Toronto).
i. McGill (Montreal).
j. Saskatchewan (Saskatoon).
k. British Columbia (Vancouver).
l. Alberta (Edmonton).
m. Lavol (Quebec).
n. Queen's (Kingston).
o. McMaster (Hamilton).

CANCER RESEARCH LABORATORIES AND HOSPITALS

p. Ontario Cancer Institute (Toronto).
q. Ontario Cancer Treatment and Research Foundation (Hamilton).
r. Montreal Cancer Institute (Montreal).
s. Saskatoon Cancer Clinic (Saskatoon).
t. Royal Victoria Hospital (Montreal).
u. Hospital for Sick Children (Toronto).
v. Hospital for Enfant-Jesus (Quebec).

D. Chile

Chile has no governmental atomic energy organization, but the Department of Hygiene, National Health Service, has under preparation regulations on the use of ionizing radiation and protection therefrom. At present, Chile's accelerator, located at the Laboratory of Nuclear Physics, is not used to produce radioisotopes, but appreciable amounts of isotopes for research and medical use are imported from the United States, United Kingdom and Holland. All research and medical activities are privately supported:

(1) Laboratory of Nuclear Physics, University of Chile at Santiago has a 800-Kev accelerator and does physical, chemical and biological research, and gives radioisotope training courses. Available equipment will soon be supplemented by a $30,000 radioisotope package training laboratory presented by the United States.

(2) Radioisotope Department, School of Medicine, Catholic University of Chile at Santiago has a facility for research and training to be supplemented with a medical radioisotope laboratory presented by the United States under the Mutual Security Act.

(3) The Radioisotopes Unit, Hospital del Salvador in Santiago, operates the largest center in Chile for diagnosis and treatment with isotopes. The hospital also has a 1,500 curie cobalt 60 teletherapy unit for the treatment of cancer.

(4) In addition, private clinics use cobalt teletherapy units. Other hospitals have radioisotope laboratories on a more modest scale, such as the radioisotope laboratory at the University at Concepcion, and the research laboratory using P–32 and C–14 at the Institute of Experimental Medicine, Medical School in Santiago.

E. Colombia

Comision de Energía Atómica de Colombia (CEAC) is planning for research to include biology. At the Instituto Nacional de Cancerologia, a Government hospital and research institute at Bogata, the present limited isotope facilities will be expended through a U.S. grant into a full-scale medical radioisotopes laboratory and cobalt teletherapy unit.

F. Costa Rica

There is a National Commission of Nuclear Energy in the University of Costa Rica. Approximately 2,400 millicuries of radioisotopes were imported during 1958–59 for use in medicine, agriculture, and industry. The Hospital San Juan has used iodine 131 for the treatment of angina, but the major use is by the Inter-American

Institute of Agricultural Sciences at Turrialba (see under OAS), which offers courses on the application of radioisotopes to agriculture, and is equipped with a gamma radiation field and a radioisotope laboratory for research.

G. Cuba

At present there are no regulations to control the importation, use or distribution of radioisotopes in Cuba. Statistical information is not available, but isotopes are imported mainly from the United States exclusively for medical use in Cuban hospitals. The University of Havana, in cooperation with UNESCO, has given a basic course on radioisotope procedures which was well attended by persons from Central America. The university is considering the possibility of giving new courses. Facilities for training are available in the Universities of Havana and Villanueva.

H. Denmark

The Danish Atomic Energy Commission was established in December 1955 for the promotion of peaceful uses of atomic energy. The Commission has established a research establishment, Risø, near the town of Roskilde. Radiation research with a bearing on the life sciences is carried out in two of the Risø research departments, namely the Agricultural Research Department and the Health Physics Department. The Danish Defense Research Board, together with the Civil Defense Authorities and the Danish Health Authorities, also sponsor radiation biology research.

Radiation Biology Research in Denmark

Category	Special comment	Funds (thousand Danish kroner)	Personnel		Who	Where
			Scientific	Supporting		
1. Radiation biology					d	d 3, 4.
2. Radiation genetics					d	d2.
3. Environmental radiation	b, c	(1)	(1)	(1)	b, c, d	b, c, d 1, 3, 5.
4. Radiation toxicology					d	d3.
5. Radiation protection	b	700	[2] 10	[2] 18	b, d	b, d 3, 5.
6. Agriculture	a	850	10	15	a	a.
7. Medical applications					d	d 3, 4.
8. Radiation detection and measurement.	b, c	(1)	(1)	(1)	b, c, d	b, c, d5.
9. Education, training, and information.	b, c				b, c, d	b, c, d3.
Total		[3] 1,550	20	33		

[1] Included in category 5.
[2] Not full-time research personnel.
[3] Approximately $225,500 at the current rate of exchange.

a. At the DAEC Risø Establishment, the Agricultural Research Department is administered by the Danish AEC but is connected with the Royal Veterinary and Agricultural College, Copenhagen, in its scientific work. The department is equipped with an 80-curie Co60 gamma field, a 1,500-curie Co^{60} gamma irradiation facility and a C14 growth-chamber. A neutron irradiation facility is under construction. Studies consist of: (1) effects of selection for disease resistance and other characters in irradiated material of cultivated plants; (2) growth inhibition and stimulation of plants; (3) extension

of storage life of fruits and vegetables by irradiation; (4) tracer experiments with radioisotopes to study the uptake of nutrients by plants; (5) root development using P 32 and a neutron soil moisture probe, and (6) service irradiation for other groups. A number of postgraduate students work in the department. Its current staff consists of 10 scientists and 15 supporting personnel, on an annual budget of approximately 850,000 Danish kroner.

b. At the DAEC Risø Establishment, the Health Physics Department does research on the environmental control of radioactivity, including sampling and radiochemical analysis, the development of special instrumentation, and meteorological studies. The department has presented four courses in radiation protection for laboratory personnel. The staff consists of 10 scientists and 18 supporting personnel, but all do not perform full-time research. The annual budget is about 700,000 Danish kroner, but not all for research.

c. The Danish Defense Research Board conducts research activities consisting of: regular measurements (since 1954) at different places, of radioactivity in precipitation and air at ground level, and radiochemical determination of different isotopes in precipitation and sea water; measurements of low-level beta radiation in samples, gamma spectroscopy, evaluation of instruments for radiation measurement. Additionally, the armed forces have operated a school since 1953 to some extent with instructors from the Board. This school has given lectures to more than 2,800 students and educated about 650 instructors on radiation measurements and protection.

d. The Danish Board of Health is cognizant of work in:

1. University of Copenhagen: Zoophysiological Laboratory.
2. University of Copenhagen: Institute of Genetics, Institute of Human Genetics.
3. Finsen Institute: Main Laboratory, Radium Station, Department of Internal Medicine.
4. University of Aarhus: Institute of Pathology.
5. Civil Defense Organization, Copenhagen.

I. El Salvador

The Nuclear Energy Commission of Salvador will be the official entity responsible for enforcing a regulation now being prepared to control the use and distribution of radioisotopes in El Salvador. The only importation to date has been 1,000 millicuries of cobalt 60 for the teletherapy unit in the Hospital Rosales. During 1959, the School of Medicine planned to initiate a basic course in the use of radioisotopes.

J. France

The Commissariat a l'Énergie Atomique (CEA) was created in October 1945, and among other things it "pursues scientific and technical research on the utilization of atomic energy in the various fields of science, industry and national defense", and "studies the proper measures to assure the protection of persons and things against the destructive effects of atomic energy." The CEA budget is in excess of 80 billion francs ($200 million) and CEA activities utilize more than 5,000 technical personnel. The portion of these devoted to research in the life sciences is not available. Research in radiation biology and

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medicine is also supported as part of broader programs, by the National Institute of Agronomic Research (NIAR), National Institute of Hygiene (NIH), National Center for Scientific Research (NCSR); by the Regional Centers Against Cancer (CRAC); and by the various clinics and laboratories of medical schools and universities.

RADIATION BIOLOGY RESEARCH IN FRANCE

MANPOWER AND ORGANIZATIONAL DATA

Category	Special comment	Number of projects	Man-years		Who	Where
			Scientific	Supporting		
1. Radiation biology	d	12	22	28	CEA	a.
	e	2			NIAR	c.
	f	13	26	20	NIH [1]	b.
2. Radiation genetics	g	3	11	7	CEA	g.
	h	3	3	2	h	b, h.
3. Environmental radiation	i	18	17	21	CEA	CEN.
	j	5			NIAR	c.
4. Radiation toxicology	k	3	11	9	CEA	a.
	l	2	2	1	NIH [1]	b.
5. Radiation protection	m	8	8	15	CEA	a.
	n	3	8	10	NIH [1]	b.
6. Agriculture	o	5	13	9	CEA	a, c.
	p	7			NIAR	c.
7. Medical applications	q	7	23	41	CEA	q.
	r	21	23	32	NIH [1]	b.
	s	4	7	3	NCSR	s.
8. Radiation detection and measurement.	t	4	7	23	CEA	t.
	u	3	4	4	NIH [1]	b.
9. Education and training	v	4			CEA	a, v.
	w	3	3	7	CEA	w.
Total		130	188	227		

[1] Most university and clinical projects were reported through the National Institute of Hygiene even though not supported by NIH. Costs and man-years were not reported in many cases.

a. Within the CEA organization is a department devoted to the life sciences, and which contains four services: Biology, radiation hygiene and radiopathology, radiation control and engineering, radiation detection. To effect its researches, CEA operates three Centers for Nuclear Study (CEN): at Saclay, at Fontenay-aux-Roses, and at Grenoble. CEA also contracts for research with universities, research institutes and national centers for scientific research, including the National Institute for Agronomic Research and the National Institute of Hygiene. The National Institute of Sciences and Nuclear Techniques is attached to Saclay, primarily as a unit for education and training.

b. The National Institute of Hygiene (NIH), containing the Central Service for Protection Against Ionizing Radiation, upon request by appropriate authorities, checks on authorized protection means and their efficiency. It makes analyses and determines the amount of radioactivity and dosage in those environments where there may be a danger to the health of individuals or of populations. Especially in cooperation with CEA, it does research for protection against ionizing radiation and on the establishment of norms, measurement methods, and precision techniques. It further maintains records and gives advice to users of ionizing radiations. The National Institute of Hygiene also sponsors research in the Regional Centers Against Cancer (CRAC) and in various clinics and laboratories of medical schools and universities.

c. The National Institute of Agronomic Research (NIAR) conducts agricultural research by contract with CEA, especially pending development of the agronomy program of the Biological Service at Saclay. The Institute maintains research centers at Antibes, Avignon, Bordeaux, Chateauroux, Jouy-en-Josas, Narbonne, Toulouse, Versailles.

d. Four of the 12 projects are contracts with various laboratories and the remainder are conducted in CEN laboratories. They consist of cellular and tissue reactions to radiation, effects of low doses, and intermediate metabolism.

e. Studies on spermatogenesis using P–32.

f. Projects at various laboratories of hospitals, medical schools and anticancer research institutes, but reported through the National Institute of Hygiene. They consist of studies on the action of radiation on cells and tissues, biological effects of radioisotopes, and actions of radiomimetic substances. Three others conducted at the Paris Hospital for Child Maladies, supported by a $20,000 grant from the U.S. Public Health Service, study fundamental cellular processes and pathological disturbances.

g. Projects supported by CEA at Saclay, National Institute of Agronomic Research and at Pasteur Institute, on changes induced in bacterial nucleic acids, genetics of plants and microorganisms.

h. Projects supported by CEA, Ministry of National Education and National Center of Scientific Research, at laboratories of medical schools and CRAC, on synchronous mitosis in yeasts, genetics by methods of quantitative biology, appearance of new characters and their mode of transmission.

i. These projects are supported by the several services of CEA and are conducted within CEN laboratories (see a). They cover control of food contamination, fundamental studies on natural radiation, particulates and effluents for safety of nuclear installations, distribution of radioactivity in aquatic organisms, permeability and role of aquatic organisms in radioactive contamination. The last studies are coordinated with the Museum of Natural History.

j. Agronomic field experiments in five Agronomic Research Centers on the relationship between radioactivity in soil and in plants. This is a 10-year study costing about 5 million francs ($12,000 at exchange rates) per year.

k. These projects conducted by CEA in its own laboratories cover control of contamination of workers by radiochemical and spectrometric methods, toxicology of fission products (notably cerium 144), their distribution in organisms and the influence of their physical-chemical characteristics. The results are watched for CEA by a liaison committee consisting of radiation officers, medics, veterinarians and pharmacists who collaborate with the Central Service for Protection Against Ionizing Radiation of NIH.

1. Studies on the toxicology of tetracarbonyl (with nickel–63), and on the detection of low levels of radioisotopes in biological fluids. The latter at the St. Antoine Hospital in Paris has a budget of 1 million francs per year.

m. Of these eight projects supported by three services of CEA, seven are conducted in CEN laboratories and one at the Pasteur Institute under contract. The latter is on protection of mammals against radiation by chemical agents; the CEN projects are on

decontamination of the digestive system and of skin, and on health physics methods and concepts for safety of nuclear installations. All are watched by the liaison committee (see k above).

n. These projects reported by NIH are conducted in medical laboratories, on the effectiveness of protective substances, and on ion exchange resins and natural absorbents administered to living animals with special attention to the radioisotopes strontium 90, cesium 137 and cerium 144.

o. CEA supports some agricultural research at Saclay and Grenoble, on plant radiobiology and sterilization of cereals by gamma rays and neutrons, but most of its support goes to INRA Research Centers for work on accumulation of radioactivity in plants from contaminated irrigation waters, equilibrium retention of radioactivity in soils, and the utilization of isotopes by livestock.

p. Projects of the National Institute of Agronomic Research, conducted in its Agronomic Research Centers, include plant physiology, soil science, and the assimilation of phosphorous and nitrogen by crops.

q. Four projects sponsored by CEA at Saclay on diagnosis and treatment with isotopes, dynamics of cholesterol labeled with carbon 14 as a clinical test, electrolyte metabolism as an indicator of pathological perturbations; three projects at clinical centers for modification of sensitivity to radiation, encephalography, blood derivatives, and diagnosis and treatment with isotopes.

r. These projects reported through NIH are carried out in 10 research laboratories of hospitals and medical schools and include: analysis by activation, study of synthetic antithyroidiens, intestinal absorption, scintillographic studies of liver and kidney function, diagnosis and localization of brain tumors, whole-body irradiation for leukemia, etiology of anemia in cancer patients treated with radiotherapy, effects of osmium on cancers, allergy to chromium, thyroid function during cancer development, iron metabolism in malignant diseases, phosphorous 32 therapy of leukemia and polycythemia, etc. Only fragmentary reports of costs on these projects are available.

s. These projects sponsored by NCSR include cervical treatment with sulfur 35 at the Laboratory for Hormonal and Cytological Experimentation, Paris; physiological and medical studies with radioisotopes at the Isotopes Center, Broussais Hospital, University of Marseille, at a cost of 5.6 million francs ($13,500).

t. Three of these projects at Saclay concern themselves with improvement of techniques for radiobiological studies, including chemical and electronic means and autohistoradiography. A fourth under contract with NCSR at Grif-sur-Yvette is devoted to improving carbon 14 measurements in living substances.

u. Projects at three clinics are on units and instrumentation for high-energy X-rays, a micro-ionization chamber, and dosimetry for cobalt 60 therapy.

v. Courses sponsored by Biological Service (CEA) in the use of radioisotopes in research are presented at the CEN laboratories (Saclay, GIF, Orsay, Grenoble), at INSTN (Saclay), and at the Mediterranean Institute for Research and Medical Application of Radioisotopes, University of Marseille. The last is by contract with CEA and is closely integrated with it. Biological Service also sponsors a 2-year course in radiobiology, with emphasis on research aspects during the second year, at INSTN.

w. CEA presents courses in radiation protection at Saclay, supports conferences and prepares films on radiation protection.

K. Federal Republic of Germany

The following statement from the Minister for Economic Affairs describes radiation research in the life sciences as conducted in Germany. Expenditures, DM3,000,000 (approximately $690,000) per year.

The German Weather Information Law in 1955 assigned to the German Weather Forecast Service responsibility for surveying the level of radioactivity in atmosphere, soil and water. Sixty different monitoring stations now cover virtually the entire Federal Republic, working under the jurisdiction of universities, colleges of technology, Max-Planck Society, Federal research agencies, state institutes, industrial enterprises, and technical inspection boards. They check: (1) air (filtered dust); (2) precipitation (including fallout); (3) soil (including plants); (4) river water, lakes and ground water; (5) drinking water; and (6) food. Some stations examine as many as 4 of the 6 fields mentioned above.

The findings of these stations are reported to the "Special Radioactivity Committee" which tabulates and analyzes them. This Committee was established in October 1956 in Berlin by the Federal Atomics Minister following a request of the Bundestag. It consists of independent expert scientists who submit scientific reports on the radioactivity level in the atmosphere, soil and water and make recommendations to the Federal Government with respect to the radiation protection of the population. The committee has a chairman, two deputy chairmen and eight members who are also members of the German Atomic Energy Commission. It is operated through a secretariat located in Frankfurt/Main and financed from Federal Atomic Ministry funds included in a DM3 million appropriation for this fiscal year under the heading "Development and Carrying Out of Radiation Protection Measures."

The first committee report was published in January 1958. A second report was completed in June 1959. A final report will be submitted as further checks and the findings of special examinations are available. This report will also include definite statements as to possible hazards affecting the population. Interim-reports evaluating further measurements will be forthcoming. The entire network of federal monitoring will eventually be fitted into the Euratom network according to the Euratom treaty.

Further ordinances in the field of radiation protection will be included in the forthcoming Federal Atomic Energy Law, as drafted by two expert teams appointed in 1956 by the "Expert Committee on Radiation Protection" of the German Atomic Energy Commission, one team considering legal and economic, the other one scientific and technical aspects. Officials of the ministries of Interior, Justice, Labor, and Atomic Energy cooperated and the German Atomic Energy Commission approved the draft provisions in 1958. Radiation protection provisions of the federal law have already been promulgated in Bavaria, Schleswig-Holstein and Berlin. Additional control measures are taken by Bavaria where the first mobile monitoring station for the determination of ionizing radiation at industrial enterprises is operated.

In July 1958 the Special Radioactivity Committee forwarded to the Federal Atomic Ministry a DM6 million research program which provided that for 2 years scientific institutes in the Federal Republic analyze pending problems of radioactive contamination and the hazards of increased radioactivity to the population, as follows:

Radiation genetics. Statistical determination of irradiation effects on germ cells, by Prof. Dr. H. Holthusen, D/Chairman of the Special Radioactivity Committee; D/Chairman of Expert Committee IV, "Radiation Protection" of the German Atomic Energy Commission.

Environmental radiation. Radioactivity of plants, food, dust particles, and effects on dairy products: Institute for Radiobiology, University of Freiburg; exchange of radioactive substances reaching and emitted from the earth by spectrum analysis: Institute for Physics, University of Heidelberg; spreading of dust through wind (protective measures to be taken in reactor safety): Meteorological Institute of Darmstadt, College of Technology; radioactive fallout in rain and dust: Munich Institute for Physics.

Agriculture. Toxic effects on food through prolonged exposure to radioactive substances in connection with food sterilization: Federal Research Institute for Food Conservation, and Institute for Physiological Chemistry of Mainz University.

L. Italy

The Biology Division of the Comitato Nazionale per le Richerche Nucleari (CNRN) was established in late 1957 in order to: (a) provide the population of Italy with services for measuring radioactive contamination of the environment and protecting against it, (b) establish research laboratories to study the biological effects of radiation and the use of radioisotopes in biology, medicine and agriculture, (c) promote such studies in already existing Italian laboratories, (d) cooperate with similar organizations and fellow scientists in other countries, (e) foster training of biologists and physicians for the development of peaceful uses of nuclear energy in Italy. These activities, outlined in the table below, are carried out in research units of CNRN (mostly in universities) and under research contracts with university institutes and laboratories. Financial and manpower data are not available.

Radiation Biology Research in Italy

Category	Special comment	Number of projects	Who	Where	Relationships
1. Radiation biology	a	4	a, i	i 4, 5	k.
		6	a, j	j 1, 3	
2. Radiation genetics	b	3	i	i 2, 4, 7	b, k.
		3	j	j1	
3. Environmental radiation	c	1	c	c	k.
		1	i	i6	
		1	j	j1	
4. Radiation toxicology		1	j	j2	k.
5. Radiation protection	d	4		j 1, 2	k.
6. Agriculture	e	4		j 1, 4	k.
7. Medical application	f	8		j 1, 2, 3; j 2	k.
8. Radiation detection and measurement	g	1	i	i3	k.
9. Education, training and information	h	5	j	j 1, 2	
Total		42			

a. Research in radiation biology is conducted over a wide range of subjects. Research units of CNRN study the action of ionizing radiation on embryonic development, on the production of free radicals in biological materials, on physiopathological responses, and problems of recovery from radiation damage. By contract with CNRN, university laboratories study radiation effects on viruses, enzymes, proteins and their synthesis, bone marrow, and other radiobiological questions.

b. Genetic studies are given emphasis, with particular attention being given to polygenic systems (that is, characteristics which result from the contributions of a number of genes) and the role which they play in experimental evolution. In studies of human populations, use has been made of consanguinity records of Catholic Church dispensations to study fertility, lifespan, anthropometrical measurements, etc. as a function of the degree of consanguinity, for populations of the 17th to 20th centuries. The project is partially supported by contract with USAEC. A study of radiation-induced mutations in plants is conducted with a 200-curie cobalt 60 source made available by the USAEC.

c. Radioactivity in the environment is studied by 22 stations which collect air samples, 13 stations which collect fallout, 17 stations which sample rivers and lakes, and by the laboratories of CNRN and CAMEN (Center for Nuclear Studies of the Armed Forces) which make measurements of radioactivity in soil, plants, food, milk, and in animal and human bones. Measurements are published semiannually. The CNRN laboratory at la Spezia studies the accumulation of radioisotopes by marine organisms and its effect on the biological equilibrium of the ocean. CNRN also conducts a study on the ecology of the "acantharia" in relation to circulation of strontium in the sea. These organisms have a skeleton normally made of strontium salts and hence may play an important role in the distribution of strontium 90 in the marine food chain.

d. Chemical protection studies under contract by CNRN are conducted to determine the biochemistry of sulfur compounds and their role in protection against ionizing radiations, and to learn the mode of action of radiomimetic (radiation imitating) substances. A film badge service has been established, and studies on chemical dosimeters and neutron dosimetry are in progress.

e. Agricultural use of radioisotopes in plant physiology is being studied in university agricultural institutes and experiment stations.

f. Studies on the application of radioisotopes and radiations in diagnosis and therapy are in progress in many clinics and medical institutes. CNRN has established medical and health services at its own research centers, namely, Center for Nuclear Studies in Ispra, National Laboratory of the Synchrotron in Frascati, and Center for Nuclear Studies in Casaccia. Other nuclear research establishments will function in the near future.

g. An instrumentation laboratory for the detection and measurement of radiations and radioisotopes is operated by CNRN at its Center for Nuclear Studies, Ispra.

h. Training courses are given, and CNRN offers scholarships to all of them: (a) a two-year course at the graduate level, on the biological effects of radiation including biochemical and genetic effects, and the use of specialized equipment, is presented at the Institute of Genetics,

University of Pavia where seminars and foreign lecturers are brought in whenever possible; (b) a course on medical uses of nuclear energy, primarily for training physicians in the use of modern radiation sources, is given at the Institute of Radiology, University of Rome; (c) courses on the use of radioisotopes in medicine, including dosimetry and radiation pathology and protection are presented by the Center for Nuclear Medicine, University of Pisa, to postgraduate medical students; (d) a course in occupational hygiene and medical protection against ionizing radiations is presented for industrial physicians, at the University of Milano with the cooperation of 12 industrial plants and scientific organizations; (e) undergraduate students are encouraged in the study of radiation biology by 15 CNRN scholarships, for study at the Universities of Milano, Naples, and Pavia which offer special courses in this field.

i. Research units of CNRN are located as follows:

1. Synchrotron Laboratory, Frascati (Rome).
2. Center for Nuclear Studies, Casaccia (Rome).
3. Center for Nuclear Studies, Ispra.
4. Various scientific research institutes in the Universities of Ferrara, Milano, Padova, Pavia, Trieste.
5. Institute of Radiology, University of Rome.
6. Laboratory for study of radioactive contamination of the sea, Fiascherino (la Spezia).
7. Advanced Institute of Health, Rome.

j. Research is sponsored by CNRN through contract with Italian universities:

1. Various scientific research institutes in the Universities of Bologna, Catania, Genova, Milano, Modena, Palermo, Padova, Parma, Pavia, Rome, Torino.
2. Various clinics and centers for nuclear medicine in the Universities of Genova, Milano, Parma, Pavia, Pisa, Rome, Torino.
3. Zoological Station, Naples.
4. Agricultural Experiment Station, Vercelli.

k. CNRN attempts to develop cooperation with foreign agencies and laboratories interested in problems of radiation research related to the life sciences, and has had a number of distinguished research workers from other countries to advise on its research program. Contacts and exchange of information are maintained with the U.N. Scientific Committee, IAEA, WHO, UNESCO, FAO, OEEC, Euratom, including cooperation on international symposia. Participation of Italian biologists in international meetings is encouraged.

M. Japan

The Japan basic atomic energy law, enacted in 1955, established the Japan Atomic Energy Commission which now has seven members and provides policy direction for the atomic energy program of Japan. The Science and Technics Agency is the administrative implementing organization within the Government. Its director-general holds a Cabinet-level post, and concurrently is also Chairman of the JAEC.

The Agency operates several national research institutes, among

them the National Institute of Radiological Sciences, at Chiba City near Tokyo. The main purposes of the institute are research on protection from radiation hazards, treatment of radiation damage, positive utilization of radiation for medical purposes, and training of personnel. The Agency also operates, through its Atomic Energy Bureau, the Atomic Energy Research Institute at Tokai, near Tokyo, which conducts research on (among other things) the biological and health physics aspects of radiation.

In addition, the Ministry of Education supports research in radiation biology in the radiation facilities in universities and research institutes. In fiscal year 1959, the Ministry of Education sponsored 33 such projects, at a cost of 37.5 million yen (more than $100,000 at exchange rates) and utilizing the services of 311 scientific and technical persons.

RADIATION BIOLOGY RESEARCH IN JAPAN

BUDGETARY (1959) AND LOCATION DATA

Category	Number of projects	Funds (thousand yen)	Location
1. Radiation biology	18	203,000	National Institute of Radiological Sciences.
	2	----------	Physical and Chemical Research Institute.
	3	2,850	3 universities.
2. Radiation genetics	2	22,000	National Institute of Radiological Sciences.
	2	9,535	National Institute of Genetics.
	4	6,150	4 universities.
3. Environmental radiation	9	93,296	National Institute of Radiological Sciences.
	1	697	National Institute of Agricultural Science.
	1	743	4 regional agricultural experiment stations.
	1	322	National Institute of Animal Health.
	3	4,521	3 regional fisheries research laboratories.
	9	15,399	Meteorological Agency.
	3	12,702	National Meteorological Institute.
	1	2,103	Maritime Safety Board.
	1	4,600	Japan Defense Agency.
	6	10,600	4 universities.
4. Radiation toxicology	2	22,600	National Institute of Radiological Sciences.
5. Radiation protection	4	45,120	National Institute of Radiological Sciences.
	1	5,260	National Institute of Industrial Health.
	4	14,920	Japanese Atomic Energy Research Institute.
	3	4,500	3 universities.
6. Agriculture	5	12,188	National Institute of Agricultural Science.
	14	22,294	5 regional agricultural experiment stations.
	5	1,421	Veterinary Experiment Station.
	3	3,854	Raw Silk Experiment Station.
	2	484	Food Research Institute.
	4	8,464	Forestry Experiment Station.
	7	5,193	2 fisheries research institutes.
	1	46,530	Agriculture, Forestry and Fisheries Technological Council.
	2	2,000	2 universities.
7. Medical applications	8	90,400	National Institute of Radiological Sciences.
	1	----------	Physical and Chemical Research Institute.
	3	7,038	Institute of Public Health.
	2	3,811	National Institute of Nutrition.
	6	21,063	National Institute of Health.
	2	10,656	National Hygienic Laboratory.
	4	5,646	National Leprosy Institute.
	6	7,677	National Sanitoria.
	10	5,520	10 universities.
8. Radiation detection and measurement.	8	90,400	National Institute of Radiological Sciences.
	1	----------	Physical and Chemical Research Institute.
	5	4,550	4 universities.
9. Education, training, and information.	1	30,000	National Institute of Radiological Sciences.
Total	180	[1] 862,077	

[1] Approximately $2,400,000 at present rate of international exchange.

N. Norway

The following statement on the organization of radiation research for the life sciences in Norway was supplied by a member of the State Council on Radiation Questions, which was established under Government auspices in 1956. No data on the amounts of funds or manpower are available.

Research in the field of radiobiology has been taken up in a number of different institutions in Norway. With a few exceptions this kind of research represents a minor part of the total activities of the institutions. This brief survey lists the most important activities under the nine categories below.

1. *Radiation biology.* Paramagnetic resonance absorption is being studied in biological systems at Norsk Hydros Institutt for Kreftforskning, Radiumhospitalet.

Physical inactivation of biological macromolecules is being studied at Fysisk Institutt avd. D, Oslo Universitet.

Studies on the metabolism of radiation protective agents are conducted at Norsk Hydros Institutt for Kreftforskning, and at Sentrallaboratoriet, Rikshospitalet.

A tissue culture unit is operating at Det Norsk Radium Hospital Department of Pathology.

Morphological, biochemical and physiological effects after radiation are being studied in skin and kidneys of mice at the Institutt for Generell og Eksperimentell Patologi, Universitetet i Oslo.

Cytological studies of radiation effects in kidneys and skin are taken up at the medical section of Statens radiologiskfysiske laboratorium.

The effect of radioactive I 131 on the kidneys of rabbits, and the effect of roentgen irradiation to the mediastinum, especially the heart, is being investigated at the Department of Pathology, Det Norske Radiumhospital.

The effect of radiation on bone marrow in rats is also studied at the same department.

2. *Radiation genetics.* Studies on radiation induced mutations in the fruitfly Drosophila melanogaster are carried out at Det Norske Radiumhospital, Department of Pathology, and at Institutt for Genetikk, Oslo Universitet.

Mutation frequency on human diseases is studied at Humangenetisk Laboratorium, Oslo Universitet.

3. *Environmental radiation.* Environmental radiation studies are performed extensively at Forsvarets Forskningsinstitutt, Kjeller. The studies include radioactivity of air, rain, soil, water, and milk, mainly with reference to the fallout elements.

Fallout measurements are also carried out at Fysisk Institutt, Norges Tekniske Høgskole, Trondhelm.

Background measurements are carried out at Statens radiologiskfysiske laboratorium, and Fysisk Institutt avd. B, Oslo Universitet.

Analyses of radioactive strontium in human bones and a few other biological materials are carried out at Kjemisk Institutt, Oslo Universitet.

Fiskeridirektorates Havforskningsinstitutt, Bergen, surveys contents of fission products in the marine biosphere.

Low-level measurements of radioactivity in foods are performed at Norsk Hydros Institutt for Kreftforskning, Radiumhospitalet.

4. *Radiation toxicology.* The metabolism of strontium has been studied at Johan Thorne Holsts Institutt for Ernaeringsforskning, Oslo Universitet.

5. *Radiation protection.* Radiation exposure to the population from diagnostic radiography is studied at Statens radiologisk-fysiske laboratorium.

6. *Agriculture.* At Norges Landbruskshøgskole, Vollebekk, studies are conducted on: genetic effects of radiation on plants; plant metabolism of elements, and contents of strontium-isotopes; pilot experiments on food sterilization by radiation.

7. *Medical applications.* A nation-wide prospective study of leukemia in relation to previous medical roentgen irradiation is conducted by Det Norske Radiumhospital. Diagnosis and treatment of disease with radioisotopes is routine activity at the main medical centers.

8. *Radiation detection and measurement.* Work in this category is carried out at Statens radiologisk-fysiske laboratorium, Institutt for Atom-energi at Kjeller, Forsvarets Forskningsinstitutt at Kjeller, and Norsk Hydros Institutt for Kreftforskning, Radiumhospitalet.

9. *Education, training and information.* Statens radiologiskfysiske laboratorium is a consultant and executive body under the national health authorities. In 1956 it was supplemented by an advisory board on radiation hygiene.

O. Peru

The entity presently responsible for the control of atomic energy is the Board of Control of Atomic Energy which has adopted the recommendations of the International Atomic Energy Agency. The Peruvian Congress is considering a more comprehensive law on the control of atomic energy. Three institutions use radioisotopes for diagnosis and treatment of disease of the thyroid. The most important is the Instituto Nacional de Enfermadades Neoplasticas at Lima, where radioisotopes are used for diagnosis, therapy and research in cancer. The institute has a 3,000-curie cobalt 60 therapy unit. Through a U.S. grant, a complete medical radioisotope laboratory will shortly be installed.

In training, the Board of Control has sponsored four 3-month courses with lectures and laboratory work on the use of radioisotopes in medicine, with emphasis on research, diagnosis and treatment of diseases, and also on the biological effects of radiation and methods of radiological protection. Courses on the use of radioisotopes in agriculture and industry have been initiated by the Head Institute of Nuclear Energy, a division of the Board of Control.

P. Puerto Rico

The Puerto Rico Nuclear Center was established in 1957 jointly by the U.S. Atomic Energy Commission and the University of Puerto Rico as part of the atoms-for-peace program, and to carry forward the proposal made by President Eisenhower at the 1956 Panama Conference that work be initiated to "hasten the beneficial uses of nuclear forces throughout the hemisphere, both in industry and in combating disease." In order to augment existing nuclear training facilities in the Americas, the USAEC selected the University of

Puerto Rico as the site for establishing a Spanish language training and research center. The Nuclear Center can thus avail itself of experts from the staffs of the university and of other affiliated and neighboring organizations for specialized instruction and cooperative research programs.

The Nuclear Center provides training and related research programs in the application of nuclear energy to the fields of agricultural, biological, medical, and physical sciences. The activities are generally bilingual, but the fact that all formal lecture courses are in Spanish greatly facilitates participation by students from the Latin American states. The center also welcomes scientists, physicians and engineers who have interests in nuclear developments.

Facilities

The University of Puerto Rico has two campuses, one at Rio Piedras near San Juan, and the other at Mayaguez. At present, the programs of the Puerto Rico Nuclear Center are carried out in buildings of the university and in two San Juan hospitals. During 1960, however, facilities will be considerably expanded. At Mayaguez, a 1,000-kilowatt pool-type research reactor, a bulk-irradiation facility which will provide dose rates of thousands of roentgens per hour, and a new 24,000 square-foot training and research laboratory, including hot and normal radiochemistry laboratories, shops, greenhouse, etc. are scheduled for completion in 1960. At San Juan, activities will be centralized and expanded by completion of a Biomedical Facility at the new Medical Center in Monacillos, near Rio Piedras. This facility will contain laboratories for work in radiochemistry, radiobiology, biochemistry, biophysics, tumor localization, cytology, and radiotherapy, as well as shops, classrooms and all related facilities.

Research and training programs

(1) *Radioisotope techniques* course is 4 weeks in length and is presented six times per year. It provides training and techniques in the use of radioisotopes, especially for physicians and biologists, and is basic to further study in radiation effects in the life sciences.

(2) *Radiation safety techniques* are presented in a 1-year professional curriculum for students who plan to specialize in the field of radiation protection (health physics), and in a 3-month program intended for physicians, public health officers, biologists, and interested graduate physicists and chemists. The latter course does not qualify the participants as health physicists, but acquaints personnel with acceptable levels of ionizing radiation, radiological techniques and equipment to teach proper and safe handling, protection of personnel utilizing X-rays and radiation sources in medical laboratories, etc. Both courses include experience in active nuclear plants or laboratories.

(3) *Medical and biological* training and research programs concern the applications of radioisotopes and the effects of radiation as studied and utilized in basic or preclinical medical science, in clinical medicine and in the specialized field of radiotherapy and cancer treatment.

In *basic medical science*, the center offers a nuclear biology course which is preparatory to supervised research in the Medical School. A short course of about 10 to 12 weeks in radiobiology demonstrates the use of radioisotopes and ionizing radiation as tools in biochemistry, pharmacology, physiology, and anatomy. An extension of this course

involves research on a problem utilizing radioisotopes and staff consultations.

Clinical applications of radioisotopes for diagnostic and therapeutic purposes are taught to provide physicians with adequate training to organize and develop medical radioisotope programs in their home institutions. There is a 2-month course, which may be followed by a year or more of study to stress the therapeutic and research aspects of radioisotopes in clinical medicine, as well as diagnostic uses.

Training in *radiation therapy of cancer* is conducted by the Radiotherapy and Cancer Division of the Nuclear Center, in the general cancer hospital facilities of the Martinez Oncological Hospital in San Juan. The purpose is to prepare physicians in the use of ionizing radiations for the treatment of cancer patients and to teach them to solve related clinical problems. Applicants with previous experience may be accepted for periods of 1 month to 1 year. The 1-year program includes inservice radiotherapy training. A 3-year residency program is also offered to provide a year of the several basic techniques described above, plus 2 years of inservice clinical radiotherapy training.

Special programs are available in exfolliative cytology for cancer diagnosis and research on response of tumors to radiation, and in the utilization of nuclear radiation in research topics such as tumor culture techniques, radiosensitivity of tumors, virsuses in cancer, etc.

Q. Sweden

The Swedish Ministry for Foreign Affairs has supplied the following account of radiation research for the life sciences, as conducted in Sweden. The amounts of funds and manpower are shown in the following table:

Radiation Biology Research in Sweden

Budgetary and manpower data (estimated)

[Dollars in thousands]

Category	Number of projects	Funds	Scientific man-years	Supporting man-years
1. Radiation biology	12		8	11
2. Radiation genetics	15		10	22
3. Environmental radiation	12		5	6
4. Radiation toxicology	10		9	10
5. Radiation protection	14		5	8
6. Agriculture	9		8	6
7. Medical applications	31		12	16
8. Radiation detection and measurement	9		8	16
9. Education, training and information			3	2
Total	112	$950	68	97

(1) *Radiation biology.*—Studies on fundamental radiobiology are conducted primarily by the Department of Radiation Biology at the Institute of Radiophysics in Stockholm. This Department is part of the Karolinska Institute as far as research and teaching are concerned as is also the Department of Radiopyhsics. Research in the field of radiation biology is also carried out at the Karolinska Institute's Department for Tumor Biology, and its Department for Cellular Research, as well as at the Research Institute of National Defense in Stockholm. In addition there are research groups engaged

in radiation biology and radiochemistry at certain universities and other institutes for higher education.

(2) *Radiation genetics.*—At the Institute of Genetics at the University of Stockholm comprehensive radiation research takes place through studies on the fruit fly (Drosophila melanogaster) and on mice. At the Institute of Racial Biology at Uppsala, radiation research in the field of human genetics has recently been started. The State Institute of Forestry Research in Stockholm conducts experiments in the field of plant genetics, including experiments with radiation, for which purpose the Institute uses a special field in the vicinity of Stockholm.

(3) *Environmental radiation.*—Studies on radiation conditions in the country are carried out chiefly by the Institute of Radiophysics and the Research Institute of National Defense, as well as to some extent by the Swedish Institutes of Meteorology and Hydrology in Stockholm and the Institute of Oceanography in Gothenburg.

(4) *Radiation toxicology.*—Studies on this subject take place primarily at the Research Institute of National Defense and at the Royal Veterinary College in Stockholm.

(5) *Radiation protection.*—Since August 1958, the Government authorities responsible for radiation protection have been the Radiation Protection Board attached to the Royal Medical Board and the Institute of Radiophysics which, in its capacity as supervising agency, performs periodic checking both of radiation protection and of the dosage applied in radiotherapy in all the Swedish establishments engaged in radiological work. Research on radiation protection is conducted at the Institute of Radiophysics in Stockholm and, insofar as radiation damage in the military field is concerned, by the Research Institute of National Defense. The Atomic Energy Company also conducts a considerable volume of research in radiation protection.

(6) *Agriculture.*—Research in this sector is carried out at the Institute of Agriculture at Ultuna, the Veterinary Institute in Stockholm, and the State Institute of Forestry Research in Stockholm. Research on the sterilization of foods is undertaken at the Institute of Technology in Stockholm.

(7) *Medical applications.*—There are 4 special centers for radiotherapy in the country; these are the 4 so-called "Jubilee" Clinics at Stockholm (Radiumhemmet), Gothenburg, Lund and Umeå. Those at Stockholm, Gothenburg and Lund have departments of clinical radiophysics linked to them and each of these is associated with an Institute of Radiophysics. Some studies on radiation problems are also carried out at the hospitals having radiological departments.

(8) *Radiation detection and measurement.*—Research in this field occurs primarily at the Institute of Radiophysics in Stockholm, but also at the Research Institute of National Defense and at the Atomic Energy Company.

(9) *Education, training and information.*—Permanent courses in radiophysics including clinical radiation physics and radiation protection are given at the Institutes of Radiophysics situated in Stockholm, Lund and Gothenburg. For engineers working in the atomic energy field, teaching is performed at the technical institutes for higher education. In addition, various organizations arrange special courses, designed for professional groups, including doctors, firemen, security engineers, industrial personnel, etc. In connection with

these courses the staffs of the Institutes of Radiophysics and the Research Institute of National Defense act as temporary lecturers.

R. Union of Soviet Socialist Republics

Scientific activities in the Soviet Union are highly organized and are controlled directly by the Government. Research in the biological and medical sciences is conducted by three major groups under the Council of Ministers: the Academy of Sciences, U.S.S.R., with its Union Republic Academies; the Ministry of Health, U.S.S.R., with its Academy of Medical Sciences, medical schools and Republic Ministries of Health; and the Ministry of Defense with its Main Medical Administration. Scientific research is also sponsored by the Ministry of Higher Education, and by the Scientific-Technical Committee of the U.S.S.R. Council of Ministers. The Academy of Sciences, U.S.S.R., and the Academy of Medical Sciences maintain liaison with one another, with the Academies of Sciences of the Union Republics, and with the scientific institutes and societies of the U.S.S.R. and foreign countries.

Radiation Biology Research in the U.S.S.R.

Category	Special comment	Number of institutes	Number of scientists	Who	Where
1. Radiation biology	d	116	742	a, b	a, b.
2. Radiation genetics	e	10	26	a, b	a, b.
3. Environmental radiation	f	31	181	a, b	a, b.
4. Radiation toxicology	g	18	88	a, b, c	a, b, c.
5. Radiation protection	h	49	204	a, c	a, c, b.
6. Agriculture		11	24	a	a.
7. Medical applications	i	65	195	a, c	a, c.
8. Radiation detection and measurement	j	23	101	a, b, c	a, b, c.
9. Education, training, and information		13	13	a	a.
Total		336	1,574		

a. Radiation research in the life sciences is carried out in the Soviet Union by some 1,574 scientists, working in 158 institutes for research in biology and medicine. These institutes have been selected from among those given in "A Directory of Medical and Biological Research Institutes of the U.S.S.R.," published in 1958 by the U.S. Department of Health, Education, and Welfare. Twenty-four additional institutes are included in the above total. The consolidated state budget has shown a steady increase in the funds devoted to scientific research, and amounted to 23.1 billion rubles in 1959. This is $5.8 billion at the official rate of exchange, but in terms of Russian purchasing power it may be closer to $1.1 to $1.6 billion. The total funds allocated to research and development, including equipment, may be close to 34 billion rubles. The portion of this devoted to radiation research in the life sciences can only be roughly estimated at $30–40 million.

b. By far the greatest amount of biological research is carried out at the institutes operated by the Academy of Sciences, U.S.S.R. The Academy is a self-perpetuating body of several hundred scientists and scholars who are responsible by law for the progress of intellectual achievement in Russia. The Academy is divided into a number of departments devoted to the sciences and humanities. Its governing body is a presidium consisting of 13 academy officers and 11 other

academicians. The presidium advises Government agencies, plans the scientific program, reviews and finances research projects, and evaluates the results. Fundamental research is carried out in the Academy institutes. Coordination between the U.S.S.R. Academy and the academies of satellite countries is effected through exchanges of delegations, and interlocking directorates. Minor research is also carried out in the laboratories of universities and medical schools, under the auspices of the Ministry of Higher Education, and applied research is conducted as required in the laboratories of the various Government ministries.

c. Medical research in the Soviet Union is largely organized, planned and controlled by the Academy of Medical Sciences, a highly centralized organization subordinate to the Learned Medical Council of the Ministry of Health, U.S.S.R. It is composed of members elected from among the leading Soviet medical scientists. Under the Ministry of Health, U.S.S.R., research is conducted by the Academy's Institutes which emphasize basic research, and by non-Academy Institutes of the Ministry where more specific problems are pursued.

d. Radiation biology research is conducted primarily as a basis for long-term progress in radiological safety. It includes studies on the mechanism of action of radiation and the relative biological effectiveness of various types of radiation. Research in these areas on the nature of radiation and its action upon the body is conducted with the hope that a rational explanation of the action will lead to a rational method of therapy, or prevention of "radiation disease." First to be considered are the primary physical and biophysical processes involved in the absorption of energy from radiation or radioactive particles; second are the subsequent tissue, cellular, chemical and other changes within the organism. Especially to be recognized is that the original event is only the initial link in a long chain of pathogenic mechanisms which lead to radiation damage, but not to be ignored are the response reactions of the organism. Much work is being done first with "models," tissue cultures or isolated organs, on the theory that basic mechanisms may thus be explored with a gradually increasing approach to the total organism. Sensitivity of various types of tissue is a topic of high interest. Soviet investigators have claimed that the central nervous system is the most radiosensitive of all tissues, and consistently emphasize its role in determining the locus and extent of radiation reaction. Another field of special interest is that of immunological response to radiation.

e. Radiation genetics has been a subject of research in the U.S.S.R. for a number of years, including the effects of ionizing radiation on human heredity, and the effects in altering hereditary traits of animals, plants and microorganisms in a desirable fashion. Soviet scientific leaders have called for a greater combined effort of scientists in many disciplines, in order to study and solve problems in radiation genetics, with special emphasis on radiation techniques to produce microbial mutants which could be useful for nutritional and physiological studies, production of antibiotics, etc.

f. Environmental studies include monitoring of particulate and other effluents, and development of air, soil, water, flora and fauna sampling techniques. Data have been compiled on fallout statistics for strontium 90 at many locations in the U.S.S.R., and the radioactivity determined in various soil, water, and biological samples.

Relatively detailed observations are being made on environmental radiation backgrounds, including fallout and contamination by atomic energy installations. Hydrobiological research is evaluating the reconcentration of isotopes from natural waters by various food chains, plants, and aquatic organisms.

g. Toxicology research includes studies on toxic effects, absorption, normal and forced excretion of many of the radioisotopes which have become important as a result of atomic energy developments.

h. Radiation protection is being accorded greatly increased attention. The new Scientific Research Institute of Medical Radiology near Moscow is in charge of all Soviet health physics, dosimetry training and planning for health physics research. Safety codes follow fairly closely the recommendations of the International Commission on Radiological Protection, and supportive research is conducted by a number of investigators in many research institutes. The Soviets have developed a total-coverage plastic suit for persons entering contaminated areas, and have devised equipment and techniques for handling isotopes and radiation, ventilation equipment and procedures, and various types of safety devices. Much shielding research is conducted along conventional lines, and also extensive research in the fields of waste disposal and methods of waste management. Prophylactic protection against radiation has included such conditions as state of nutrition and general physical condition, oxygen concentration, body temperature and some 80 chemical substances which have been tested mostly on an empirical basis. Some attention has been given toward therapeutic removal of radioisotopes which may have been deposited in the body, and much emphasis is being placed on treatment of "radiation disease."

i. Medical applications of radioisotopes for diagnosis and therapy increased rapidly following the 1955 Geneva Conference. In general, these forms of application are quite similar to those in use outside the U.S.S.R. Objectives of the program include perfection of radiotherapeutic techniques, and the development of production and medical use of radioisotopes.

j. Instruments for the detection and dosimetry of radiation have been developed in large numbers. In general, these conform to equivalent Western types, and include integrating dosimeters, alpha-beta-gamma dosimeters and detectors, neutron detectors, film badges and pocket dosimeters, etc. Research in the principles of dosimetry is being given increased attention since adequate dosimetry lies at the base of studies on biological response to radiation.

S. United Kingdom

Information given below on research in the United Kingdom was provided by the AEC Office in London. Radiation research in the life sciences and associated fields is done in both private and public institutions. Government support accounts for most of the research in this field in the United Kingdom. Detailed financial data are not available for administrative reasons.

The principal government organizations are the Medical Research Council (MRC), the Agricultural Research Council (ARC), the Department of Scientific and Industrial Research (DSIR), and the Atomic Energy Authority (AEA). Nongovernment support is pro-

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vided through means such as the British Empire Cancer Campaign (BECC) and various privately supported institutions. No significant share of the research work in this field is undertaken by military agencies.

Under the recent reorganization of the Cabinet, activities of the MRC, ARC, DSIR and the AEA have become the responsibility of the Minister for Science. Financial support is derived principally from funds voted by Parliament, but in some cases, especially for the AEA, funds are also derived from the sales of products and services. Contributions from other government agencies and other sources also provide significant income.

RADIATION BIOLOGY RESEARCH IN THE UNITED KINGDOM

ORGANIZATIONAL DATA

Category	Number of projects	Special comment	Who	Where
1. Radiation biology	1		MRC	A1.
	21	A2a	MRC	A2a.
	6	A2c	MRC	A2c.
	2	A2d	MRC	A2d.
	11		MRC	A3 a, b, c.
	11	A4 a, b, c	MRC	A4 a, b, c.
	1		MRC	A5b.
	13	D	BEEC	D1.
	7	D	BEEC	D 2, 3, 6.
	6	D	BEEC	D7.
	8	D	BEEC	D 9, 11, 12.
	11	D	BEEC	D10.
	9	D	BEEC	D 13, 15, 16.
	4	D	BEEC	D 17, 18, 19.
	28		Miscellaneous	E.
2. Radiation genetics	13	A2a	MRC	A2a.
	1	A2d	MRC	A2d.
	1		ARC	B1.
	3	D	BEEC	D 1, 7, 10.
3. Environmental radiation	1	A2f	MRC	A2f.
	1	A4b	MRC	A4b.
	1		MRC	A5.
	4		ARC	B2.
	1	C1	AEA	C1.
	2	D	BEEC	D 1, 14.
	3		Miscellaneous	E.
4. Radiation toxicology	8	A2a	MRC	A2a.
	1	A2b	MRC	A2b.
	1	A4b	MRC	A4b.
	1		MRC	A5c.
	2		ARC	B 3.
	3	D	BEEC	D1.
5. Radiation protection	2	A2a	MRC	A2a.
	1	A2c	MRC	A2c.
	2	A2f	MRC	A2f.
	2	C2	AEA	C2.
	2		Miscellaneous	E.
6. Agriculture	5		ARC	B 4, 5, 6.
7. Medical applications	10	A2b	MRC	A2b.
	4	A2e	MRC	A2e.
	2		MRC	A3c.
	7	A4b	MRC	A4b.
	2	A4c	MRC	A4c.
	1		MRC	A5d.
	10	D	BEEC	D 1-8.
	9	D	BEEC	D 9-11.
	31		Miscellaneous	E.
8. Radiation detection and measurement	3	A2a	MRC	A2a.
	4	A2b	MRC	A2b.
	1	A2c	MRC	A2c.
	7	A2f	MRC	A2f.
	2		MRC	A3b.
	11	A4b	MRC	A4b.
	1	A4c	MRC	A4c.
	6	D	BEEC	D 6, 7, 10, 14.
	16		Miscellaneous	E.
9. Education, training, and information		C3	AEA	C3.
Total	325			

A. *Medical Research Council.*—By far, the most important sponsor of radiation research in the life sciences is MRC. It is responsible to the Committee of the Privy Council for Medical Research. Its Chairman is Minister for Science. It has 12 members, 9 of them scientists. The Council's chief function is to undertake or promote scientific investigations to obtain new knowledge likely to be of value in the field of curative and preventive medicine. It has the advice of a large number of expert committees which it appoints for the purpose. In general, the arrangements for the support of research fall under three headings:

1. Investigations by members of the Council's scientific staff, mostly working in the Council's own research establishments.
2. Temporary research grants to independent investigators in universities and elsewhere.
3. Research scholarships and fellowships for work both at home and abroad.

For the financial year ending March 31, 1958, the total expenditure of public funds by MRC was approximately $8,500,000 (not including Public Health Laboratory Services), of which 10 to 20 percent was devoted to radiation research in the life sciences. The MRC does not exercise close technical coordination, but depends upon the interests and special capabilities of the scientific community to establish the direction of its research efforts.

Radiation research programs undertaken by the Medical Research Council, and numbers of senior technical personnel (stp), are located as follows:

A1. National Institute for Medical Research, London.

A2. Research units and groups:

a. Radiobiological Research Unit (50 stp), Atomic Energy Research Establishment, Harwell; studies the action of ionizing radiations on living organisms, tissues and cells, with particular attention to fast neutrons, X- and gamma radiations.

b. Radiotherapeutic Research Unit (20 stp), Hammersmith Hospital, London; seeks to improve the radiation treatment of disease, and makes investigations to assess the therapeutic value of different types of radiation.

c. Experimental Radiopathology Research Unit (10 stp), Hammersmith Hospital, London; studies the mechanism of action of ionizing radiations on living cells in relation to the radiotherapy of cancer, and investigates metabolic changes induced by radiation and encountered in various diseases, with emphasis on enzyme reactions in metabolic investigations.

d. Group for Research on the General Effects of Radiation (5 stp), Western General Hospital, Edinburgh; is concerned with the delayed effects of radiation exposure on man, especially the role of cell genetic damage in the etiology of these effects.

e. Betatron Research Group (5 stp), Christie Hospital and Holt Radium Institute, Manchester; studies the application of megavoltage to radiotherapy, and performs work on the chemical and biological effects of megavoltage with special reference to the efficiency of 20 million volt radiation, and studies special varieties of cancer as part of the plan of defining the proper place of high voltage therapy in the treatment of malignant diseases.

f. Radiological Protection Service (12 stp), jointly with the Ministry of Health, Belmont, Surrey; aims to carry out research of a physical nature into the problems concerning the protection of workers and of the public from the effects of ionizing radiations, and to act as a central organization for controlling radiation hazards.

A3. External scientific staff:

a. Surgical Science Department, University of Edinburgh.

b. Medical Physics Department, University of Leeds.

c. Christie Hospital and Holt Radium Institute, Manchester.

A4. Institute of Cancer Research, Royal Cancer Hospital, London:

a. Chester Beatty Research Institute (5 stp); studies the mechanism of action of carcinogenic and mutagenic chemical agents, cytology and cytogenetics, control mechanisms in normal growth, tumor viruses, experimental chemotherapy.

b. Physics Department (20 stp); investigates physical aspect of the clinical use of isotopes and high energy radiations, and various aspects of carcinogenesis by radiations including studies of environmental contamination.

c. Radiotherapy Department (15 stp); makes clinical studies of malignant diseases and the results of treatment, the use of radioactive isotopes for therapy and investigation, and other radiological research.

A5. Research work aided by grants:

a. Biological Chemistry Department, University of Aberdeen.

b. Barnato Joel Laboratories, Middlesex Hospital.

c. Pharmacology Department, Churchill Hospital, Oxford.

d. Inorganic Chemistry Department, Oxford University.

B. *Agricultural Research Council.*—The ARC was established by Royal Charter in 1931. It is responsible to the Committee of the Privy Council for Agricultural Research of which the Minister for Science is chairman, and the Minister of Agriculture, Fisheries and Food is vice chairman. The ARC consists of 18 members, of whom 9 have been appointed for their scientific qualifications; the remainder are persons with a general experience and interest in agriculture, and representatives of the agricultural departments of government.

The Council plans and coordinates work over the entire field of agricultural research and is assisted in this task by standing committees and a number of technical committees and conferences. The Council has 22 research institutes and units under its direct control in Great Britain. It also supervises the programs, estimates and staffing of 15 research institutes in England, and advises the Department of Agriculture and Fisheries on the control of 8 institutes in Scotland; these institutes are almost wholly financed from State funds, but most of them have their own governing bodies.

In addition the ARC devotes part of its funds to encouraging research by means of special research grants which are allocated to one or another of the research institutes, to university departments or to advisory centres. It also awards scholarships and training grants. For the current fiscal year, total expenditures are about $14,760,000, of which over 3 percent is devoted to radiation research.

Radiation research programs undertaken by ARC are located as follows:

B1. Pirbright Institute (Animal Virus Diseases), Woking: irradiation-produced mutations.

B2. ARC Radiobiology Laboratory (6–8 stp), Wantage: determines the levels of radioactivity in agricultural produce in Great Britain which results from world-wide fallout, and studies the factors which affect the movement of fission products through the soil/plant chain.

B3. ARC Field Station, Compton, Newbury; Rowett Research Institute, Bucksburn: metabolism and toxicity of radioactive substances in farm animals.

B4. John Innes Institute, Hertford; Plant Breeding Institute, Cambridge; Welsh Plant Breeding Station, Aberystwyth: irradiation in plant breeding.

B5. National Institute for Research in Dairying, Reading: use of radioactive materials in metabolic studies.

B6. Low Temperature Research Station, Cambridge: irradiation in food preservation.

Department of Scientific and Industrial Research.—The DSIR does not sponsor directly radiation research in the life sciences. However, its program contributes indirectly to other United Kingdom scientific programs, especially in the area of basic physical standards, which are maintained by the National Physical Laboratory at Teddington, Middlesex.

C. *Atomic Energy Authority.*—The AEA is the official Government agency in the United Kingdom responsible for the development of atomic energy. It is analogous to the USAEC, with one important difference being that the AEA owns and operates directly research and production facilities. The Authority is composed, at present, of a chairman and 10 members, 5 of whom are full-time. Its annual budget is well over $280 million. The program of the AEA, although of very wide scope, provides for little radiobiological research as such. However, to meet its own needs the AEA does undertake significant programs in the areas of radiation protection and training, as follows:

C1. Environmental radiation: The AEA participates in the comprehensive monitoring system which has been established in the United Kingdom for radiostrontium in food, rainwater, drinking water, and human bone. Responsibility for its supervision lies primarily with the ARC and MRC. The AEA is responsible for measurements of specific radionuclides in air at one stage, in rainwater at 6 places in the United Kingdom and 18 places overseas and also measures the activity of specific nuclides in 16 representative sources of drinking water. Discharges to the air, ground, and water from nuclear energy establishments are monitored to meet the requirements of the responsible Government departments. The AEA also does considerable monitoring of biological materials and with responsible Government departments it examines, inter alia, milk, animal thyroids and long bones, marine and fresh water, flora, fauna and river water.

C2. Radiation protection: The Radiological Protection Division of the AEA collaborates with various health and safety organizations in the various AEA establishments on control of radiological and other

hazards and on the associated programs of investigation and research. It is organized to cover the main scientific disciplines involved, viz. health physics, occupational medicine and radiobiology.

C3. Education, training and information: The AEA takes the lead in building up a supply of health physicists and nuclear safety experts commensurate with the needs of the AEA and future needs of the nation as a whole, and also operates training centers for health physics and nuclear safety staff. It has set up a Committee to study the problem of health and safety training. The Committee has interpreted its terms of reference widely and has been considering needs for training, both for full-time health and safety staff, and for people requiring only a background knowledge of radiological health and safety. The Committee has also given some attention to the need for improved public information. It has thus been concerned with training courses at all levels—from M. Sc. or Ph. D. courses lasting up to 3 years, to background courses lasting a fortnight, a week or less—and also with the various training and information media such as films, broadcasting, articles and books. The Committee is not concerned with radiobiological research as such, except as higher levels of education and training may include a considerable element of research or project work. Note: The Veale Committee report was published in April 1960.

D. *British Empire cancer campaign.*—The BECC is one of the principal independent organizations which sponsor research in radiation biology (as well as other fields). It is composed of the Central Organization and four autonomous councils. The campaign is operated under the Grand Council of which the Duke of Devonshire is the chairman. A scientific advisory committee serves the Council. Among various subcommittees of the Scientific Advisory Committee is that on Radiology and Physics. Funds for support of the campaign are obtained mainly from donations, collections, legacies, and interest on investments. Expenditures for the main objects of the campaign amounted, during the year ending December 1958, to about $17,800,000. In addition, about $295,000 was expended by the autonomous councils. Of the total, a relatively small part was expended in radiation research. The majority of the studies supported are basic studies on the response of cells to radiation, factors which modify this response, and the underlying consideration in terms of physical and chemical changes which take place in the cell at the time of irradiation. Other studies have to do with the potential hazards associated with long-term exposure to ionizing radiation, and the use of radiation as a therapeutic agent.

Radiation research programs undertaken by BECC are located as follows:

D1. Institute of Cancer Research: Royal Cancer Hospital, London.
D2. Middlesex Hospital.
D3. Guy's Hospital Medical School.
D4. London Hospital Medical College.
D5. Marie Curie Hospital.
D6. Mount Vernon Hospital and the Radium Institute, Northwood, Middlesex.

D7. Cancer Research Committee, St. Bartholomew's Hospital.
D8. St. George's Hospital Medical School.
D9. Cancer Research Department, Westminster Hospital.
D10. Research Departments, Christie Hospital and Holt Radium Institute.
D11. BECC Cambridge University Research Center.
D12. Oxford Cancer Research Committee, University of Oxford.
D13. BECC North of England Council (King's College, University of Durham Royal Victoria Infirmary, Newcastle upon Tyne), and Queen Elizabeth Hospital, Gateshead.
D14. BECC Yorkshire Council (Department of Medical Physics of the University of Leeds, and the Radiotherapy Center at Leeds).
D15. Royal Free Hospital and School of Medicine, London.
D16. Harefield Hospital, Middlesex.
D17. General Hospital, Northampton.
D18. St. John's Hospital for Diseases of the Skin, London Institute of Dermatology.
D19. University of Cambridge (Departments of Pathology and Radiotherapeutics).

E. *Other radiation research programs.*—Miscellaneous sources of funds are available to support many research projects in 21 British universities and medical schools. These are indicated in the table under "Miscellaneous."

T. Uruguay

The National Commission of Atomic Energy, located in Montevideo, studies and coordinates atomic energy activities in Uruguay but does not possess control and developmental powers. It has, however, initiated plans for a National Center for Atomic Energy under the direction of the University of Montevideo.

The university possesses good equipment, mostly through a Rockefeller grant. The Institute of Radiology at Montevideo has good medical radioisotopes equipment for diagnosis, therapy and clinical research. Two private clinics own two teletherapy units consisting of 2,000 curies of cobalt 60. Two more units are planned for official institutions. One of the private units is used partly for agricultural studies, such as irradiation of plants for genetic research and irradiation of food for preservation.

The University of Montevideo is acquiring biochemical, medical diagnostic and cobalt teletherapy radiation laboratory equipment through a U.S. grant. This, added to the limited equipment now possessed by the Biophysics Department of the Medical School, will make possible a good program in the biomedical uses of atomic energy.

The School of Engineering and Agriculture at Montevideo conducts training in radioisotope techniques and research, and in cooperation with the Medical School, it gives courses on dosimetry and medical applications of radioisotopes.

U. Venezuela

Instituto Venezolano de Investigaciones Cientificas (IVIC) in Caracas is an autonomous institution financed by the Government and attached to the Ministry of Health and Social Assistance for administrative purposes. It conducts most of the atomic energy activities and has some of the best facilities in Latin America, including radioisotope laboratories for biophysics, biochemistry and medical research and training. With the completion of a research reactor near Caracas, these researches are expected to be intensified.

In general, the Ministry is also in charge of health protection in Venezuela and hence has legal power to regulate importation, use and distribution of radioactive material. Some 515 millicuries of radioisotopes were imported from the United States during 1959 for medical and biological use. In medicine, the use has been principally in the diagnosis and treatment of thyroid diseases and in hematological diagnosis.

To date, only one course has been given on radioisotopes, but it is planned to give the course three times a year in the IVIC beginning in 1960.

Part 4

INTER-GOVERNMENTAL ORGANIZATIONS

A. United Nations

The United Nations is an organization composed of 99 nations who have accepted the obligations contained in the Charter which was drawn up and signed by 31 nations at the San Francisco Conference in 1945. Among its objectives are: to cooperate internationally in solving international economic, social, cultural and humanitarian problems; to be a center for harmonizing the actions of nations in attaining these common ends.

Much of the work toward achieving these ends is carried out through a provision of the Charter that—

> various specialized agencies, established by inter-governmental agreement and having wide international responsibilities, as defined in their basic instruments, in economic, social, cultural, educational, health, and related fields, shall be brought into relationship with the United Nations * * *.

The instruments defining this relationship consist of individual agreements between the U.N. and the specialized agencies. The agencies of interest to this report are: Food and Agriculture Organization (FAO); International Labor Organization (ILO); United Nations Educational, Scientific and Cultural Organization (UNESCO); World Health Organization (WHO); World Meteorological Organization (WMO); and the autonomous International Atomic Energy Agency (IAEA) which is under the aegis of the U.N.

In addition, the U.N. General Assembly occasionally takes independent action. In 1955, it established by resolution its Scientific Committee on the Effects of Atomic Radiation (SCEAR). Likewise, in 1954, acting upon advice of a small committee (consisting of respresentatives from Brazil, Canada, France, India, U.S.S.R., United Kingdom, and the United States), the General Assembly resolved that an international technical conference should be held under the auspices of the U.N. to explore means of developing the peaceful uses of atomic energy through international cooperation. Plans were prepared in consultation with FAO, WHO and UNESCO, and invitations to participate were issued to all 60 State Members of the U.N. and to 24 other members of its specialized agencies. Thirty-three nations and eight specialized agencies were represented at the first Conference on Peaceful Uses of Atomic Energy, held in Geneva in August 1955. Representatives offered 1,132 abstracts and 1,067 full papers, of which 450 were selected for oral presentation.

A second such Conference was held in Geneva in September 1958, with the additional assistance of WMO and IAEA. Representatives from 69 Member States and 9 specialized agencies participated, offering 2,535 abstracts and 2,135 full papers, of which 714 were selected for oral presentation. A sizable proportion of the papers accepted and published by both Conferences lay within the radiobiology categories of interest to this report.

I. INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

The IAEA was proposed by President Dwight D. Eisenhower to the General Assembly of the United Nations in December 1953. The statute came into force on July 29, 1957. As of December 31, 1958, 70 States were members of the Agency. The Agency is authorized—

to encourage and assist research on, a development and practical application of, atomic energy for peaceful uses throughout the world; and, if requested to do so, to act as an intermediary for the purpose of securing the performance of services or the supplying of materials, equipment, or facilities by one member of the Agency for another; and to perform any operation or services useful in research on, or development or practical application of, atomic energy for peaceful purposes.

The Agency also has a responsibility to develop, in collaboration with other responsible bodies, standards for radiation safety. Research is promoted by the award of research contracts, by the education and training program and by the dissemination of information.

TABLE A.—RADIATION BIOLOGY RESEARCH BY IAEA

FISCAL, MANPOWER AND ORGANIZATIONAL DATA, 1959

Category	Special comment	Number of projects	Funds	Man-years		Who	Where
				Scientific	Supporting		
1. Radiation biology	c	1	$9,910	3.0	2.0	a	Austria.
		2	15,000	3.5	4.0		United Kingdom.
		3	28,400	3.0	5.0		France.
		1	7,800	2.0	1.0		Germany.
		1	5,000	2.0	4.5		Italy.
		1	5,500	2.0	1.0		Switzerland.
		2	6,840	4.5	3.0		Poland.
		1	5,635	2.0	2.0		Yugoslavia.
2. Radiation genetics	d	1	9,150	2.0	1.0	a	Finland.
		2	10,360	3.0	3.0		Japan.
		1	8,000	1.5	3.0		Norway.
		1	13,965	1.0	1.0		Sweden.
3. Environmental radiation	e	1	6,000	1.0	2.0	a	Argentina.
		1	5,800	1.0	1.0		Austria.
		1	5,100	2.0	1.0		France.
		4	2,740	.5	1.0		International.
		1	14,700	2.0	3.0		Italy.
		2	8,000	2.0	3.0		Japan.
4. Radiation toxicology	f	1	23,350	2.0	2.0	a	Sweden.
		1	10,500	1.5	1.0		Switzerland.
5. Radiation protection	g	2	10,975	2.5	3.0	a	Austria.
		1	12,000	1.5	1.0		Belgium.
		1	8,000	3.0	1.0		Netherlands.
		1	15,000	2.0	2.0		Czechoslovakia.
		2	7,000	3.5	3.0		Yugoslavia.
6. Agriculture	h	1	4,024	1.0	1.0	a	Austria.
		3	10,840	4.0	9.0		Japan.
7. Medical applications	i	2	7,920	2.0	2.0	a	Greece.
		1	5,000	2.5	2.0		Thailand.
		1	10,200	2.0	2.0		Philippines.
		2	4,800	3.0	2.0		Iraq.
8. Radiation detection and measurement.	j	1	7,000	1.5	1.0	a	Italy.
		1	4,500	3.0	3.0		New Zealand.
9. Education, training and information.	k, l					b	
Total		48	309,009	73.0	76.5		22 nations.

a. *Radiation research* for the life sciences is actively sponsored by IAEA through its Department of Research and Isotopes which combines the Division of Research and the Division of Isotopes. The Department utilizes the services of a Committee for Contractual Scientific Services. This Committee consists of representatives from

11 divisions within the Secretariat who consider the appropriateness of research proposals from Member States, as to the interests of the Agency, of the State and of research needs throughout the world. In principle, all Member States which are believed by the Secretariat to have the necessary facilities and personnel for carrying out a research project or a study planned by the Secretariat are offered the opportunity to do so. The Member State which first proposed a project subsequently approved has first opportunity to carry it out within the budgetary limitations. In 1959, the Agency sponsored $309,000 worth of research contracts among 22 Member States, utilizing about 150 scientific and supporting man-years of effort. Contracts are renewed when necessary, some 1958 contracts being carried into 1960. It is planned to continue the contract program indefinitely.

b. The Department of Training and Technical Information also is concerned with the life sciences. It consists of: (1) the Division of Exchange and Training of Scientists and Experts, which directs the Agency's fellowship program and the exchange of technical personnel between Member States, and also assists Member States in developing training programs, and in establishing cooperatively financed regional training centers; and (2) the Division of Scientific and Technical Information, which collects and disseminates information to Member States, organizes and coordinates conferences and symposia, edits and publishes conference proceedings, maintains a scientific reference library including films, and encourages standardized international nomenclature.

c. *Radiation biology* studies (in order) consist of: electrophysiological responses of nerve cells to small doses of X-rays, reasons for differences in radiosensitivity of micro-organisms, primary biochemical lesions in mammalian tissue, effects on virulence and antigenic activity of viruses, radiosensitivity and isolation of resistant strains of bacilli, mechanism of activation and inactivation of bacterial spores, modifications induced in nucleic acids under various conditions, quantitative cell survival, changes in electrophysiological response of nervous system under localized irradiation, proteolysis of labeled fibrinogen, spectroscopic analysis of products of gamma irradiation of solutions, radio-iron study of the role of anemic factor in blood regeneration.

d. *Radiation genetics* projects: mutation rate at specific loci in different species of Drosophila, stability of genetic materials containing radioisotopes, mutation rates induced by acute and chronic irradiation, radiosensitivity of spermatogonia of Drosophila, effect of radiation on genetics of human cells.

e. *Environmental radiation* projects: behavior of fission products in soils, distribution of fission products in biosphere, root and leaf absorption of radioisotopes in herbaceous plants; by the international Working Group on Oceanographic Radioactivity: four projects on measurements of natural and fission activity in oceans, sediments and marine organisms; uptake, accumulation and loss of radioactive material by marine bacteria; contamination in Japanese marine resources, uptake of radioisotopes by edible marine products.

f. *Radiation toxicology* projects: radio-calcium metabolism in man, biological effects of radium and radio-strontium accumulations in humans.

g. *Radiation protection* projects: protective action of sulfhydril compounds against radiation effects on the synthesis of DNA, wood

as an ion exchange substance in waste treatment, changes in radiation sensitivity resulting from chemically induced metabolic modifications in cells, intracellular chemical radiation protection substances, two-step grafting of hematopoietic and germinal tissues to counteract radiation sterility, recovery effects of injected highly polymerized nucleic acid, changes in nucleic acids isolated from irradiated organisms.

h. *Agriculture* projects: modification of effects of radiation on plant cells, isotopes for fertilizer evaluation, uptake of wastes by lowland rice from contaminated soil and water, application of radiation induced mutations to plant breeding.

i. *Medical application* projects: liver scanning after administration of radioiodine-labeled Rose Bengal, iron metabolism and red cell life span (using radio-iron and -chromium) in anemia cases, radioisotope study of hemoglobin, cause of endemic goitre in the Philippines, red cell life span in anemic patients, etiology of tropical iron-deficiency anemia.

j. *Radiation detection and measurement* projects: monitoring and dosimetry for low fluxes of fast neutrons using a bubble chamber; human teeth as indicator of strontium 90 in the population.

k. *Education and training* is sponsored through a program of fellowships, including training in health physics and other aspects of the life sciences; special training in the application of radioisotopes to medicine, biology, agriculture and radiation protection; a program for the exchange of visiting professors, scientists, experts and consultants; internationally organized training courses in specialized radioisotope research techniques, such as that jointly sponsored by IAEA and FAO in cooperation with the U.S. Government and Cornell University where the course was presented in July 1959. Another was presented in Buenos Aires in December 1959 in collaboration with the Government of Argentina, and one is planned for New Delhi in 1960.

l. The fellowship program provides three broad types of training: general training in fundamental techniques with emphasis on instrumentation and dosimetry; specialist training in the theoretical and experimental aspects of nuclear science and technology; research training for personnel possessing the capacity to undertake research work in specific fields to which nuclear energy can be applied, as biological research. Most fellowships are of 1 year or less in duration, but some of 5 to 6 years' duration are offered by certain Member States. Extensions of fellowships may be requested and approved. A limited number of "research grants" may be awarded to scientists and engineers with active research interests in nuclear energy. In 1958, 147 fellowships were awarded for use in 28 countries. By April 1959, about 500 nominations had been received and 356 were selected for awards. In 1959, the Agency's General Fund allotted $425,000 and an additional $175,000 was allotted by the U.N. Expanded Program of Technical Assistance; $865,000 has been approved for 1960, and Member States will add to the number of available fellowships. These fellowships are not all specifically for training and research in the life sciences, although fellows specializing in other fields in most cases receive some training in radiation effects as part of their programs of study.

II. SCIENTIFIC COMMITTEE ON EFFECTS OF ATOMIC RADIATION (UNSCEAR)[1]

The Scientific Committee on the Effects of Atomic Radiation was established by Resolution 913(X) of December 3, 1955, at the 10th session of the General Assembly. It has the following members: Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Japan, Mexico, Sweden, Union of Soviet Socialist Republics, United Arab Republic, United Kingdom of Great Britain and Northern Ireland, United States of America. The Committee considers it essential that its sessions be attended by the widest possible group of experts whose advice its members can bring to bear on their deliberations. The Committee's discussions in 1959 may be grouped under the categories of this report, as follows:

1. *Radiation biology.*—The Committee emphasized that further advance in radiobiology depends mainly upon progress in general biology which must be given strong support and research effort, and therefore recommended that the specialized agencies of the U.N. and other bodies give adequate support to fundamental biological research, stimulate this research by organizing frequent exchanges of new information, possibly by holding interdisciplinary symposia, and help in the training of specialists through fellowships. Better understanding of fundamental biology should result in better understanding of the effects of ionizing radiation, the fields of genetics, carcinogenesis and ageing. Special attention needs to be paid to:

Molecular biology, especially polynucleotides.

Cell physiology and cell chemistry.

Structure of polynucleotides, their role in the transfer of genetic information and in protein synthesis.

Mechanisms of mutation and possible recovery processes of genetic damage, comparative nature of induced and spontaneous mutation, and the fate of mutational changes in a population.

Role of genetic mechanisms in somatic cell variation.

Chemical composition of cell structures carrying genetic information; role of specific minerals, such as strontium and calcium as microelements necessary for normal cell function.

Regulation of cell growth and cell differentiation, role of different cell structures in normal functioning of the cell, problem of ageing on the cellular level.

Nature of cellular processes leading to tumor development.

The value of recent advances in relevant methodology such as the method of *in vitro* cultivation of mammalian cells.

2. *Radiation genetics.*—The Committee recognized that the recent progress in molecular biology of DNA is an important and most critical approach to the understanding of fundamental radiobiology and of genetic effects of ionizing radiation in particular. It noted that the genetic effects of radioisotopes incorporated into the body have so far been considered mostly as consequences of molecular changes caused by ionizations only; that the recoil of the decayed radioactive atom and the change of its chemical characteristics would, however, also lead to mutations if the radioisotopes (H^3, C^{14}, P^{32}, P^{33}) have been incorporated into DNA molecules of the genetic material; and, further, that experiments made to obtain basic data on relative efficiencies of ionization and of transmutation or recoil in

[1] Prepared from U.N. Report A/4119, June 15 ,1959.

specific locus mutation would enhance the accuracy of the quantitative assessment of the biological hazards of radioactive contamination. Certain viruses and micro-organisms give the greatest promise of the profitable attack on this problem because of the precise genetic technique available. Since some of the somatic effects may reflect mutations in somatic cells or damage of their genetic apparatus, studies of the molecular effects of radioactive decay of incorporated radioisotopes may be important not only for the understanding of genetic hazards but also for the explanations of such somatic effects as carcinogenesis, aging or even acute lethality.

The Committee suggested to WHO that it continue its work in the field of human genetics and that it consider convening in the near future an expert group for the discussion of the distribution and maintenance of genetic defects in populations; and that it would welcome the results of such a meeting. The Committee also considered important the study of the significance of alterations in the sex ratio as a possible indicator of radiation-induced genetic disturbance in human populations, and it sought the close cooperation of WHO in a study of this problem.

The Committee considered it desirable that a seminar be held in the near future to review how best to use and adapt national civil registration practices and vital and health statistics for genetic purposes and other considerations relevant to the radiation problem and that such a seminar be held under the joint sponsorship of the United Nations and the World Health Organization, if possible in 1960. It therefore decided to recommend to the General Assembly that such a seminar be held and to suggest to WHO that it cosponsor such a seminar.

3. *Environmental radiation.*—The Committee planned to discuss problems relating to the stratospheric fallout mechanism and to emphasize the need for further information of specific kinds bearing on this problem. It also welcomed the cooperation of the World Meteorological Organization (WMO), asked that organization to assist it in its discussions by making available relevant information from conferences, and invited the participation of a group of experts of WMO in its discussions of the problem.

The Committee emphasized the continued importance for its work of further studies of the movement of radioactive nuclides in food-chains and the value of the work carried out and of the information submitted to the Committee by States Members of the United Nations and members of the specialized agencies and of IAEA.

The Committee expressed its continued interest in studies of populations exposed to relatively high levels of natural radiation, and stated that it considered such studies to be important, and would welcome reports on their progress.

4. *Education, training, and information.*—In addition to the recommendation for training of biologists (category 1, above), the Committee is interested in disseminating the information it gathers. It plans to report to the Assembly on each phase of its scientific work separately, as it is completed, and to submit a comprehensive self-contained document during or before 1962.

Program for the Near Future

The Committee plans to include the following topics as its main subjects for study:

Physical aspects of fallout.

Physical and biological problems concerning the transmission of fission products through food-chains.

The relationship between radiation dose and effects, particularly at small-dose levels.

Physical and biological problems concerned with carbon 14.

Genetic problems.

Relations of the Committee With Other Bodies

The Committee welcomed the offers of cooperation it had received from the specialized agencies of the United Nations, from the International Atomic Energy Agency and from the International Commission on Radiological Protection and the International Commission on Radiological Units and Measurements. It anticipated that its work would be assisted by the IAEA because of that Agency's expanding work in subjects related to the question of radiation. The Committee drew the attention of the General Assembly to the requests for studies and information that it has made to specialized agencies of the United Nations, to the International Atomic Energy Agency and to other bodies, and emphasized that these requests were made in order to assist the Committee to carry out the obligation assigned to it by the General Assembly for evaluating the effects of ionizing radiation on man and on his environment.

III. WORLD HEALTH ORGANIZATION (WHO)

The WHO Constitution was drawn up in 1946 by the International Health Conference. In April 1948, the Constitution, having been ratified by 26 Member States, entered into force. The Agreement with United Nations became effective in July 1948, and WHO took over the functions of the League of Nations Health Organization, and the health work of the U.N. Relief and Rehabilitation Administration. As of June 30, 1959, WHO had 87 members and 3 associate members. Among the functions devolving upon WHO are those of promoting and conducting research in the field of health; promoting improved standards of teaching and training in the health, medical and related professions; assisting in developing an informed public opinion on matters of health. WHO activities include a program dealing with ionizing radiation and the health aspects of atomic energy.

WHO has responsibilities in radiation protection and the various other phases of radiation health, and in the use of radiation and isotopic methods in health work. It has a direct concern and an active program in the various health aspects of ionizing radiation. Because of the nature of this field the program has always included research activities. These research activities are at the present time expanding in a very significant way in connection with the WHO intensified program in medical research.

It is a basic principle of WHO to operate through existing national organizations. This principle applies also to research. It is con-

sidered that it would be a mistake for WHO to duplicate the work of existing national centers for research by creating international centers for such work. The Organization's role, rather, is to encourage the highest possible development of national centers and to use these as the bases on which to construct a worldwide cooperative effort in those fields whose progress depends upon such cooperation. Particular attention is given to those aspects of investigation which are not, or cannot be, easily carried out by national efforts alone but require collaboration of workers in different parts of the world. Special consideration is given also to research which is basically of an international character. The following outline of WHO research activities in the radiation field includes projects, many of which are still in early phases of development.

1. *Radiation biology.*—Probably the most pressing need in this field, as far as human health is concerned, is for scientifically reliable actual data on the effects on man himself of ionizing radiation, particularly in the low dose range. Such information is necessary for the development of sound programs in radiation health and for basic understanding of the health problems involved.

The WHO research program includes a number of studies on groups of patients receiving radiation therapy and persons with internally deposited radioactive material. Included also are studies of groups of patients who have been subjected to certain types of medical diagnostic radiological procedures. Since such groups are generally of somewhat limited size in any one country, international collaboration is needed to facilitate the collection of significant data. WHO is in a particularly favorable position to assist in the initiation and coordination of such investigations.

2, 3. *Radiation genetics and environmental radiation.*—WHO has a broad interest in human genetics, including radiation genetics, in relation to health problems. Lack of fundamental information presents a serious obstacle to progress in the understanding of the possible genetic effects on man of low level irradiation. WHO is approaching this question from several points of view:

(a) To build up our basic knowledge of the incidence and nature of genetic defects in human populations, and to provide a firmer basis for measuring the possible genetic effects of radiation exposure, the Organization is initiating a coordinated study of human births in a number of different countries.

(b) Because the most urgently needed data are those to be obtained from man himself, WHO has been assisting with the planning of studies on large population groups living in areas of high natural radiation. The WHO Expert Committee on Radiation issued its first report (Technical Report Series No. 166, 1959) on "The Effect of Radiation on Human Heredity," with special emphasis on the Kerala and Madras monazite regions of India, where the background radiation dose amounts to approximately 1.3–1.5 rads per year to about 80,000 people. These populations thus receive 10–15 times as much ionizing radiation as most people, an amount estimated to be within the range necessary to double the mutation rate.

Demographic studies on these populations in India are of special interest and the Expert Committee has framed broadly based studies which it is hoped will provide valuable data on a number of aspects of human genetics in addition to those related to possible radiation

effects, and contribute fundamental information on our knowledge of human biology generally. Possibilities of more effectively utilizing vital and health statistics for studies in human genetics and in radiation health will be taken up in a Seminar jointly organized by the United Nations and WHO in 1960.

4. *Radiation toxicology.*—Human data on radiotoxicology are very limited. The most significant information we have in this whole field has been obtained from persons internally contaminated with radium. It is of great importance that our basic information in this field be expanded by quantitative studies of persons bearing other types of internal radioactive deposits. A large group of such persons are patients who have received medically administered thorium dioxide. An international collaborative study of such individuals in a number of countries is being initiated and assisted by WHO.

5. *Radiation protection.*—A very large part of WHO's regular program in radiation health deals with protection. Research activities are closely linked with this program. The question of treatment of radiation injury has been considered specifically by research advisory groups in human radiobiology; and an international symposium on the diagnosis and treatment of radiation injury is being organized jointly by WHO and IAEA, to be held in 1960. Problems related to the public health aspects of radioactive waste disposal were discussed at a WHO seminar on this topic in 1959. Surveys in various parts of the world and studies of radiation protection techniques are also a part of the WHO program. WHO works very closely with, and has sponsored, the International Commission on Radiological Protection (ICRP) for a number of years.

6. *Agriculture.*—WHO maintains a very close liaison with the Food and Agriculture Organization in all questions of radiation health associated with such problems as radioactive contamination of soil and agricultural products, and also in the matter of radiation sterilization of food.

7. *Medical applications.*—WHO is concerned with a number of epidemiological studies on patient groups exposed to medical radiation of various sorts. Such groups represent important sources of information on radiation effects on man and are particularly important because possibilities of obtaining direct information on man are very sharply limited. The investigations are aimed at developing data on the possible relationship of leukemia, cancer, and other diseases to various levels and types of irradiation, including both X-rays and radioisotopes, and therapeutic and diagnostic exposures. Attention is also given to research in the medical application and use of radiation and radionuclides in health work. WHO, jointly with the International Atomic Energy Agency, held a seminar in 1959 on medical radioisotope scanning and in 1960 will organize a seminar on the use of radioisotopes in studies in tropical medicine.

8. *Radiation detection and measurement.*—WHO works closely with the International Commission on Radiological Units and Measurement. This Commission has been in official relationships with WHO for a number of years. A program for international intercomparisons of X-ray and radiation measurements standards has been undertaken jointly by WHO and UNESCO with the assistance of ICRU and the U.S. National Bureau of Standards. This project has involved the construction of standard measuring instruments for use in comparing

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various national standards. Intercomparisons have been carried out both in the low and high energy range.

WHO jointly with FAO is studying the matter of sampling and measurement of radioactive nuclides in various types of sample, and has prepared a collection of methods of radiochemical analysis for laboratories concerned with radioactive measurement in connection with health work. This is a continuing program; further measurement questions will be considered this year and in the future. It is anticipated that the IAEA will be able to help in this activity.

9. *Education, training and information.*—Education and training has always been a very large and important part of WHO activities. The fellowship program covers many different phases of the radiation field, such as radiological protection and hygiene, medical use of radioactive isotopes and human genetics in its relationship to radiation problems. Seminars and symposia are convened to consider various specific problems in the field. Close contact is maintained with other international bodies in the education and training field.

IV. FOOD AND AGRICULTURE ORGANIZATION (FAO)

FAO was established in 1945 as a specialized agency of the United Nations, with responsibility for promoting the utilization of such technical advances as can contribute to its basic aim of improving levels of nutrition and standards of living throughout the world.

FAO's activities in connection with atomic energy date from late 1954, when the General Assembly of the United Nations adopted a resolution stressing the importance and urgency of international cooperation in developing the peaceful uses of atomic energy, and called upon the competent specialized agencies to assist in its implementation. The freer availability of radioactive isotopes and radiation as a byproduct of the development of atomic energy is of greatest immediate significance for agriculture and related industry.

With the rapid technical and international development in atomic energy and the increasing demands made upon FAO in this field, a separate Atomic Energy Branch was established in 1957. This Branch serves a central coordinating and policy-guiding function for all matters relating to the application of atomic energy to food and agriculture, including fisheries, forestry and human nutrition. The Branch is also responsible for the general external relations in connection with atomic energy, and for the development and operation of an action program on behalf of FAO in consultation and cooperation, as necessary, with other technical branches and divisions concerned.

The projects to be described below under the pertinent categories have been carried out by the professional staff of the Atomic Energy Branch consisting of the Chief of the Branch and one technical officer. This segment of FAO also operates through, and in cooperation with officers in other technical branches and divisions of the Organization. In addition, much of this work is conducted with the assistance of short-term consultants. The activities of the Branch during the past year, including consultants and personnel for the training course have required practically 3½ scientific man-years, of which 2 man-years correspond to the permanent staff and the remainder to consultants and lecturers used in the training course. Additional supporting effort for the Branch during 1959 amounted to 2⅝ man-years.

3. *Environmental radiation.*—FAO responsibilities to the applications of atomic energy techniques relate specifically to the food, agricultural, and fisheries aspects of the problems of environmental radioactive contamination resulting from the expanding use of atomic energy. Attention, therefore, is given to the collection, interpretation and dissemination of available technical information on the possible adverse effects that contamination of the air, soil and water by radioactive material might have on food-producing resources and food supplies.

In this connection, the Director General established an Expert Committee on Radioactive Materials in Food and Agriculture, composed of 13 members and three consultants, which met at the headquarters of FAO in Rome in December 1959. The purpose of this Committee was to advise on the nature and scope of work that should be undertaken by FAO in response to a recommendation of the 10th session of the European Commission on Agriculture in May 1958, and in response to a resolution of the 6th session of the United Nations Scientific Committee on the Effects of Atomic Radiation. UNSCEAR had indicated that it would welcome detailed and continuing consideration on an international basis by FAO of the problems of radioactive contamination of food and agriculture, in order that the Organization might assist the Committee to carry out the responsibilities assigned to it by the General Assembly for evaluating the effects of ionizing radiations on man and his environment. The final report of this Committee was submitted as a working document for the seventh session of the United Nations Scientific Committee on the Effects of Atomic Radiation. FAO has also taken part in the International Atomic Energy Agency Panel on Radioactive Waste Disposal into the Sea, established in 1959.

6. *Agriculture.*—Atomic energy has many important and highly promising applications in agriculture, fisheries and nutrition. For the time being, the use of radioisotopes and radiation, which have become more freely available as a byproduct of the development of atomic energy, is of greatest immediate significance for agriculture and related industries.

The importance of radioisotopes in these fields arises from their unique value as a research tool in a wide range of investigations. Through their use in studies in such fields as soil fertility, crop nutrition and physiology, crop protection, pest control, livestock physiology and pathology, ocean and inland water productivity, and animal and human nutrition, notable contributions are being made to fundamental knowledge that is already leading to the improvement of methods of production and utilization of food and other agricultural products. Radiation, for its part, offers promise of important new methods of preserving and processing food and other agricultural products, while its ability to induce mutations provides a valuable addition to methods of breeding improved varieties of crop plants.

In order that countries in a region may benefit from the many substantial advances that are being made through the use of these important techniques, through the free exchange of information on current activities, the European Contact Group on the Uses of Isotopes and Radiation in Agricultural Research was established under the aegis of the Subcommission on Agricultural Research of the European Commission on Agriculture. The first meeting was held, by cour-

tesy of the Government of the Netherlands, at Wageningen in December 1956, and attended by 31 representatives of 16 European Member Governments, and by observers from 1 European nonmember government and 8 international organizations. As a result of this meeting FAO has been maintaining active and close contact with leaders in the use of these new techniques. FAO is considering the possibility of organizing another meeting of this Group, maybe in 1960, limited to recent advances in animal physiology and nutrition research, with special reference to the use of radioisotopes. In addition, during the next year a Symposium on the Effects of Ionizing Radiations on Seeds and Its Significance for Crop Improvement is being planned.

In the field of food sterilization FAO organized the European Meeting on the Use of Ionizing Radiations for Food Preservation, held by courtesy of the Government of the United Kingdom at the United Kingdom Atomic Energy Authority's Research Establishment at Harwell in November 1958. This meeting was convened in response to a recommendation of the first (Wageningen) meeting of the FAO European Contact Group on the Uses of Isotopes and Radiation in Agricultural Research. Its purpose was to survey the present status of food irradiation, make critical evaluation of the potentialities of this new technique for European countries, and consider the need for and possibility of organizing international cooperation in research on food irradiation in Europe. Participation in the meeting included 176 representatives of 17 European member governments and 14 international organizations.

Following up a recommendation of the Harwell meeting, FAO is considering the possibility of organizing a meeting on Radiation Microbiology during the first half of 1960.

8. *Radiation detection and measurement.*—FAO cooperated with WHO in convening a Joint Expert Committee on Methods of Radiochemical Analysis in Geneva in September 1958 to make recommendations regarding suitable methods of analysis for use in public health and agricultural laboratories new to those techniques. A report was issued, in which the first three sections discuss in general terms the sources of radioactive contamination, the evaluation of environmental contamination, and the evaluation of internal contamination of the human body. The final section contains a selection of radiochemical (and physical) methods for the determination of important radioactive elements in various types of samples together with a description of sampling methods.

9. *Education, training and information.*—Among FAO activities in atomic energy which should be included in this category is the FAO/IAEA International Training Course on Radioisotope Techniques in Agricultural Research applied to food and agriculture, organized by FAO and the IAEA in cooperation with the Government of the United States of America and Cornell University. This course was held at the Laboratory of Radiation Biology of that University in September 1959. It was designed specifically to give research workers in agriculture, forestry, fisheries and nutrition from various countries an intensive coverage of the theory of radioisotope usage and up-to-date laboratory practices. In the lectures and panel discussions 10 scientists participated who are recognized as international leaders in their fields, plus some of the staff of the Radiation Biology Laboratory.

Another FAO activity in connection with this group of activities is the European Seminar on the Training of Agricultural Advisory Services on Agricultural Aspects of Environmental Radioactive Contamination, which was organized in cooperation with the Government of the United Kingdom at Cambridge, England, in September 1959. This seminar, which was arranged in response to a request of the European Commission on Agriculture at its 10th session in May 1958, presented an outline of the factual information that should be available to agricultural and veterinary advisory officers to enable them to inform farmers of the nature and degree of environmental radioactive contamination that may arise from the expanding use of atomic energy, and to enable them to advise on the nature of protective and remedial measures that may be taken insofar as agriculture is concerned. The organization of supervisory services that will be required in agricultural administrations and their regulatory and advisory responsibilities were also discussed. This seminar was organized for senior officers in national agricultural and veterinary advisory or extension services; also for senior administrative officers now or likely to be in charge of the legal and technical aspects of the control of the release of radioactive materials to the environment insofar as food and agriculture may be affected.

Other ways by which FAO helps in promoting the proper utilization of atomic energy techniques in food and agriculture is by granting fellowships for training or research in specific fields of applications of radioisotopes and radiation. Such fellowships are already being made available under the Regular and Expanded Technical Assistance Programs and through funds-in-trust.

In its program of work FAO is playing an important part in fostering a wider knowledge of the benefits that atomic energy can bring to agriculture and related industries. This is being accomplished through the preparation and publication of documents and reports such as the paper entitled "The Potential Contribution of Atomic Energy to Development in Agriculture and Related Industries," which provides the first available critical review of the significance of atomic energy for food and agriculture.

V. INTERNATIONAL LABOR ORGANIZATION (ILO)

ILO was established in 1919 by the Peace Conference as an autonomous body associated with the League of Nations. It became associated with the United Nations as a Specialized Agency in 1946 under an agreement which recognized the responsibility of ILO in its own field of competence, that is, to raise working and living standards throughout the world, including protection of the worker's life and health. Its principal function is the formulation of international minimum standards of working and living conditions, embodied in International Labor Conventions and Recommendations. Within ILO, the Occupational Health and Safety Division (one of 25 divisions) is the one concerned with radiation health protection. Two members of the Division, a physician and a physicist, are responsible in the main for the collection and processing of information and reports on the subject.

Ignorance of the potential dangers of radioactive materials during the 1920's had led to cases of aplastic anemia and bone sarcoma among

women employed in the luminizing industry in the United States. Experience was accumulating also on the deleterious effects of X-rays. Although most of the information emerged from the ill-effects of their use in medical practice, their introduction into industry was accompanied by similar effects. From this early stage the International Labor Office collected information on the topic. The encyclopedia of occupational health entitled "Occupation and Health" published by the Office between 1932 and 1934 contained articles on the occupational pathology of roentgen ray operators, radium and radioactive substances and uranium.

In 1934 the Workmen's Compensation (Occupational Diseases) Convention (Revised), 1934, now ratified by 32 member states, included pathological manifestations due to X-rays, radium and other radioactive substances, among the occupational diseases for which compensation might be claimed. The workers covered at that time were mostly those working with medical and industrial X-ray units or engaged in luminizing and laboratory work.

1. *Radiation protection.*—Following the war, when the potential of atomic energy for peacetime purposes was beginning to become more fully appreciated, the Office set about preparing a comprehensive *Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry.* This included a section on ionizing radiations, which was, in fact, the first set of international standards on radiation protection in industry. Atomic energy installations were beginning to lose their exclusively military character and were in a position more and more to provide industry with isotopes which had far-reaching and hitherto unknown industrial applications.

International standards.—The Protection of Workers' Health Recommendation, 1953, provided, inter alia, that all appropriate and practicable measures should be taken "* * * to shield workers from harmful radiations", but no other international instrument contained provisions relating to the prevention of radiation injuries. The rapid development of industrial applications of the products of atomic energy, however, persuaded the Governing Body of the ILO in 1957 that the time was ripe for the adoption of international standards in this respect. Accordingly in 1958 a report was prepared, including a survey of the law and practice relating to radiation protection throughout the world, and including also a questionnaire, in which governments were asked about the desirability and the content of an international instrument or instruments on radiation protection.

On the basis of the replies to this questionnaire a second report was prepared which embodied a draft convention and recommendation. This was discussed at the International Labor Conference in June 1959. Following this discussion a third report was prepared and sent to governments and, in the light of their replies, a final report was prepared and submitted in June 1960 to the International Labor Conference, which finally adopted a convention on the protection of workers against ionizing radiations and a supplementing recommendation.

The international instruments are conceived along very general lines and apply to all activities involving exposure of workers to ionizing radiations in the course of their work.

Because of the experience with radiations and radioactive substances since the beginning of the century the atomic energy industry was in

a better position than any other industry has ever been to appreciate the potential dangers of its product. The emotional impact of this new source of power introduced a respect and a fear which is without parallel in any other industrial hazard. Consequently the development of nuclear installations and research centers proceeded with a higher standard of precautions against the effects of overexposure than any other industry had ever done. The same cannot always be said, however, of the increasing number of other industries which are using their products. The problem facing those concerned with the question of precautions against ionizing radiations in industry is to introduce an intelligent appreciation of their potential dangers and a standard of precautions on an entirely new and unusual level.

The rapid development of nuclear energy and the increasing number of industrial applications of radioactive isotopes and X-rays made it necessary to revise the 1949 Model Code by a group of experts which met in Geneva in December 1957. The provisions of the Model Code are limited in scope to industrial establishments using sealed or unsealed radioactive substances or operating equipment capable of producing ionizing radiations; they do not apply, for example, to uranium mines, basic chemical or metallurgical factories treating natural radioactive materials or nuclear fuels, facilities for the bulk storage of radioactive substances, nuclear reactors or high energy accelerators for the production of radioactive nuclides. The Model Code represents a set of standards which, although by no means binding on members of the Organization, nevertheless reflect the best preventive practice; they have already been used by several states in the formulation of their national legislation or other standards.

Danger symbol for radiations.—Considerable difficulty has been experienced in achieving international agreement on a symbol for radioactive substances. The Chemical Industries Committee, at its fourth session in 1955, adopted a series of danger symbols for the marking of packages containing dangerous substances and one of these symbols is for radioactive substances. The symbol, which was taken over in 1956 by the United Nations Committee of Experts on the Transport of Dangerous Goods, is designed to indicate the specific danger of radiation to workers the world over without the need for any inscription. After discussions a modified symbol has been recommended. The ILO continues to work towards international agreement on this subject and recently attended meetings of the IAEA and of the Central Office of International Railway Transport in Berne, at which the subject was discussed and progress made toward agreement.

9. *Education, training, and information.*—Standards by themselves are insufficient. They must be illuminated by educational resources in the form of articles, lectures, training guides, and courses of study. The Office has published a number of articles dealing with radiation protection in its periodical *Occupational Safety and Health.* It also presented reports to the Radiation Protection Sections of the United Nations Conferences in 1955 and 1958 on the Peaceful Uses of Atomic Energy. Three training guides are in an advanced state of preparation. The first outlines the general principles of radiation protection. The second deals with the technical aspects of protection in industrial X-ray and gamma radiography and fluoroscopy, while the third is concerned with the protection of workers against the effects of radiation in the widespread, if small, industry of luminizing which has its

own peculiar dangers and problems and which, as it uses open sources of high toxicity, calls for the most stringent precautions. These three guides will form parts 3, 4, and 5 of the ILO Manual of Industrial Radiation Protection, parts 1 and 2 of which will comprise the international instruments and the relevant section of the Model Code.

Two training courses have already been organized in which labor inspectors, safety engineers and industrial medical officers participated. The first course was given in the United Kingdom in 1958, with the cooperation of the U.K. Atomic Energy Authority, and the second one was held in France in 1960, with the aid of the Commissariat à l'Énergie Atomique.

The ILO has just established an International Safety and Health Information Center in which it has the collaboration of the International Social Security Association. This will commence operations on January 1, 1960, and its work will consist in providing abstracts of articles published all over the world on all aspects of occupational safety and health, including information on radiation protection.

Cooperation with other organizations.—Apart from the cooperation described above in connection with danger symbols, the Office has close relationships with the World Health Organization and was represented at its most recent meeting on Medical Supervision in Radiation Work. It also has close relations with the International Atomic Energy Agency with which the ILO concluded a relationship agreement in 1958. The IAEA, in its Manual on the Safe Handling of Radioisotopes, has incorporated many of the provisions of the ILO Model Code. The ILO Model Code incorporates the latest recommendations of the International Commission on Radiological Protection and the International Commission of Radiological Units and Measurements, with which organizations the ILO also maintains close liaison. Finally, it maintains contact with regional and national organizations in this field as well as with individuals who write for information on specific aspects of radiation protection in industry.

VI. WORLD METEOROLOGICAL ORGANIZATION (WMO)

WMO was formally established in April 1951, as a result of the action of the International Meteorological Organization, at which time all the activities, resources and obligations of IMO were transferred to WMO. In December 1951, the U.N. General Assembly approved an agreement which established WMO as a Specialized Agency of the U.N. WMO, in addition to the promotion of meteorological and weather information services, promotes the application of meteorology to aviation, shipping, agriculture and other human activities; encourages research and training in meteorology; assists in coordinating international aspects of such research and training.

WMO does not of itself carry out research of any kind, nor does it operate any meteorological facilities, but its activities in the field of atomic energy are in terms of its directive to encourage and coordinate research and training, and it seeks to ascertain and make known to all member states the results of research in any country which may enable radioactive techniques to be used to assist the science of meteorology and its applications. To this end, it reestablished in 1959 a panel of experts to advise on: preparing a WMO program on the application of atomic physics and radioisotopes to problems of

meteorology; preparing and distributing technical notes and reports; coordinating WMO activities with those of other international organizations; standardizing instruments and methods of observation for the collection of radioactivity data and meteorological data by WMO.

WMO activities come within the following four categories of this report:

3. *Environmental radiation.*—WMO has two interests in this field: the use of radioactive isotopes as tracers in such problems as large-scale air mass movements and turbulent diffusion in the atmosphere; application of meteorological knowledge to questions of radioactive atmospheric pollution, for the movement of such substances in the atmosphere is dependent upon meteorological factors such as winds at various levels, vertical movements in the atmosphere, rainfall and stratospheric-tropospheric interchange. WMO is coordinating these activities with other interested organizations: a briefing of the UNSC (U.N. Scientific Committee) early in 1960; joint representation with IAEA on the WMO Panel in 1958 in Geneva, and at the IAEA meeting in Vienna, 1959, on the collection and analysis of radioactivity in the Biosphere; working arrangements with UNESCO, International Council of Scientific Unions, and International Union of Geodesy and Geophysics, on network measurements of atmospheric radioactivity.

6. *Agriculture.*—In the application of meteorology to agriculture, studies are being made to improve instrumentation based on the use of isotopes for measuring such elements as precipitation, soil moisture, evaporation, etc. These studies are being carried out by the Panel, and by the WMO Commission for Agricultural Meteorology, and in close collaboration with the U.N. Food and Agriculture Organization.

8. *Radiation detection and measurement.*—The Panel is committed—

to study the problems of standardization of instruments and methods of observation for the collection of radioactivity data, together with meteorological data within the existing framework of the WMO.

WMO has long aimed at such standardization by issuing technical regulations and guides, with satisfactory results. WMO has advised the UNSCEAR on the best method of obtaining international standardization of samples of precipitations.

9. *Education, training, and information.*—Members of WMO are kept regularly informed about the work of the Panel and relevant Technical Commissions. A bibliography of all papers relating to the application of atomic physics in meteorology, and on the meteorological safety aspects of the planning, construction and operation of atomic energy plants, is distributed regularly to all members of WMO. WMO submitted a paper to the second Geneva Conference (1958) on the meteorological aspects of the peaceful uses of atomic energy, with a view to making known to a large technical audience the problems and achievements in this subject.

VII. UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO)

A constitution for UNESCO was adopted in 1945 by representatives of 44 governments, and an agreement between the U.N. and UNESCO was approved by the General Assembly of the U.N. in New York during its October–December 1946 session. Among its aims is that of encouraging cooperation among nations in all branches of intellec-

tual activity. In the natural sciences, UNESCO develops international scientific cooperation by organizing meetings among scientists, assisting activities of international scientific organizations and by promoting exchange of scientific information. UNESCO does not itself carry out research. It does not possess research institutes and does not direct work carried out in such institutions but it does sponsor activities which contribute to the progress of knowledge of radiation effects on the life sciences, such as the International Conference on Radioisotopes which was held in Paris in September 1957 and whose proceedings were published in 1958 (Library of Congress, Card No. 58–11219, etc.). Its activities according to the categories of this report are as follows:

8. *Radiation detection and measurement.*—Early in 1957 UNESCO contracted with the U.S. National Bureau of Standards for the construction of an ionization chamber to use as a secondary standard for X-rays and gamma rays. This project was the direct result of a resolution adopted by the United Nations Scientific Committee on the Effects of Atomic Radiation, recommending joint action by UNESCO and the World Health Organization in this field. Since its construction, the chamber has been sent to several countries, among which are Australia, France and the Federal Republic of Germany.

9. *Education, training, and information.*—Since 1955, UNESCO convenes a yearly meeting of consultants within the framework of the cell biology project, which establishes, amongst others, programs of symposia. In 1958 they drew up the following program for the next few years:

1. International Symposium on Immediate and Low-Level Effects of Ionizing Radiations, held at Venice in June 1959 under the cosponsorship of the International Atomic Energy Agency, the Comitato Nazionale per le Ricerche Nucleari of Italy and UNESCO. Subjects covered by this conference fell under the categories of radiation biology, radiation gentics, and radiation detection and measurement.

2. Conference on the Disposal of Radioactive Waste was held in Monaco, November 1959, in collaboration with the International Atomic Energy Agency.

3. Symposium on the Regulatory Mechanisms of Growth Processes will be held at Wassenaar, Netherlands, in August 1960.

4. A round-table type symposium on The Initial Effects of Ionizing Radiations on Living Cells, will be held in Moscow, U.S.S.R., in October 1960.

5. Symposium on Radiobiology in Relation to Cell Theory and Ageing will be held in 1962, the place of meeting to be chosen later.

Relations of UNESCO With Other International Scientific Nongovernmental Organizations

Of the international scientific nongovernmental organizations which receive regular financial assistance from UNESCO, two are interested in radiation research: the Council for International Organizations of Medical Sciences (CIOMS) and the International Council of Scientific Unions (ICSU). CIOMS was created as a nongovernmental organization in 1949 under the joint sponsorship of UNESCO and the World Health Organization. As regards the International Council of Scien-

tific Unions there existed in 1956 an ad hoc Committee on the Biological Effects of Nuclear Radiations. This committee was dissolved early in 1957, after a decision of the Bureau of ICSU not to take further action other than informing the United Nations Scientific Committee on the Effects of Atomic Radiation of the willingness of ICSU to cooperate, through UNESCO, in the field of the biological effects of nuclear radiations.

Since 1956 ICSU has maintained a Joint Commission on Applied Radioactivity (present President is Henry Seligman of the International Atomic Energy Agency). This commission joins the Unions of Chemistry, Physics, Biological Sciences, Geodesy and Geophysics, Biochemistry, and Physiology in an inquiry concerning radioactive tracers, new radioactive elements, and reaction kinetics.

B. Organization of American States (OAS)

The OAS, established in 1890, was long known as the Pan American Union (PAU). The charter and present name became effective in 1951, part of the aims being to promote by cooperative action their economic, social and cultural development. Twenty-one American States are members: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, United States, Uruguay, Venezuela. Agreements have been concluded with a number of inter-American specialized organizations, three of which have an interest in promoting radiation research for the life sciences: Inter-American Institute of Agricultural Sciences, Inter-American Nuclear Energy Commission, Pan-American Health Organization.

Inter-American Institute of Agricultural Sciences (IAIAS)

The IAIAS at Turrialba, Costa Rica, is a specialized agency of the Organization of American States. It was established in 1945 in response to the need for agricultural research programs, extension courses, education, and improved farming methods. Rapidly increasing populations and the influx of people to the cities have combined to make increased agricultural productivity essential in all of the countries of Latin America. The program of the institute provides graduate study and opportunities for research. It is divided into three main departments: Plant Industry, Animal Husbandry, and Economics and Rural Life.

Radiation research has, to date, been carried out only in the Plant Industry Department. Under a grant from the USAEC a gamma-ray field for the study of mutations and other changes in plants was completed in April of 1958. A cytological laboratory for work in connection with the field has now been completed. Studies on coffee, cacao, and banana plants make up the bulk of the work in the gamma-ray field, though some other plants have been included. Another project, also sponsored by the USAEC involves the use of radioisotopes in plants and soils. Its purpose is to study the uptake, storage, and translocation of food in plants and in the movements of nutrients in the soil in relation to crops, fertilization and leaching by means of the application of tagged elements. Isotopes have also

been used in studies of insecticides used on the cacao tree under a cooperative agreement between the Department of Entomology of the University of Wisconsin and the Cacao Center at the Institute.

Training.—During the 5-year period 1954–59, 313 students were trained in the institute. Of them 61 were candidates for the master's degree, 30 were special students, 211 attended short courses, and 11 took inservice training. Of the total, 217 were registered in the Department of Plant Industry. They came from all of the member states of the OAS as well as from Europe and Asia. Fellowships for training at the institute have been granted by the U.S. International Cooperation Administration, the U.S. Atomic Energy Commission, the American Cocoa Research Institute, the International Regional Sanitation Organization for Plants and Animals, the American International Association, the Rockefeller Foundation, the Food and Agriculture Organization, and the Organization of American States.

The Scientific Information Service provides bibliographic and documentation services in the fields of plant industry, animal husbandry, and rural economics for scientists throughout Latin America. Project 39 of the Program of Technical Cooperation of the OAS, entitled "Technical Education for the Improvement of Agriculture and Rural Life," has its headquarters at the Institute and carries on extension work from three centers—Havana, Cuba (Northern Zone); Lima, Peru (Andean Zone); and Montevideo, Uruguay (Southern Zone).

INTER-AMERICAN NUCLEAR ENERGY COMMISSION (IANEC)

The IANEC was established by action of the Council of the Organization of American States (OAS) in 1959, as—

> a commission of a technical nature within the Organization of American States, established to serve as a center of consultation for the states and to facilitate cooperation among them in matters relating to the peaceful application of nuclear energy.

The Commission is composed of officially designated representatives from each of the 21 nations which make up the OAS; it has technical autonomy and may make recommendations of a technical nature directly to the member governments through their respective representatives on the Commission.

The Secretariat of the Commission is located in the Pan American Union, the organization which serves as the General Secretariat of the OAS, as part of the Division of Science Development. The nuclear sciences and the natural sciences are interdependent. Their close relationship and concurrent development is of particular importance in Latin America where there is a rapid growth of all branches of science.

The first meeting of the Inter-American Nuclear Energy Commission was held in Washington, D.C., at the seat of the Pan American Union in October 1959. Fifteen of the member nations were represented. The second meeting was held in July 1960, in Petropolis, Brazil.

The Inter-American Nuclear Energy Commission does not engage directly in any research or training activities although its entire program is aimed at the coordination and stimulation of research and development in all aspects of nuclear science and its applications and in the support of the education and training of the technical and

scientific personnel that such a program requires. Education and training, information, and liaison are the three major divisions of the program.

Education and training.—At its first meeting, IANEC established an ad hoc committee to formulate a "coordinated and complete plan for the development of training, education and research in the nuclear sciences in the Americas." It directed that this plan should give initial priority to the subjects of physics and mathematics of nuclear science, nuclear engineering and technology, geology and mining of nuclear materials, and:

1. Use of isotopes in scientific research, in agriculture, medicine, and industry;
2. Health and safety in the use of nuclear materials.

The first step in the development of the plan was to assemble information concerning the facilities which could be made available by institutions and organizations in the various countries for cooperative training in those fields and a general outline of the contribution each member state could make to the program together with such assistance as scholarships for students, visiting professorships, and material aid in the form of laboratory equipment and instruments which would be required. Also required was general information to determine: exact number of students that could be trained; qualifications to be required of students; detailed subject matter to be taught; facilities available and a detailed estimate of requirements for additional facilities and equipment, including costs; numbers of visiting professorships required; housing availability for students; subsistence and other factors; administrative matters including details of the contributions of the host governments and/or institutions. When this information has been collected and organized, it will provide a sound basis for a realistic, efficient program for the development of the cooperative training program.

Nuclear energy development is based upon development of the natural sciences, including biology. Programs for the improvement of training and education in those fields are being supported by the Division of Science Development and general programs of the OAS. The OAS fellowship program has awarded 23 fellowships in the natural sciences and 17 in engineering. Universities in Latin America and the United States are cooperating in this program.

Under a cooperative program of the OAS and the U.S. National Science Foundation, 20 fellowships will be awarded to Latin American secondary school science and mathematics teachers for study in the 1960 summer science institutes in the United States. The purpose of these summer schools is to strengthen the subject matter competence of secondary school teachers, and to relate the latest research results to classroom presentations in general biology, radiation biology, chemistry, mathematics, physics, and general science. Although these institutes have been supported by the NSF for a number of years, this is the first time that fellowships have been offered to teachers from the countries of Latin America. This program represents a significant opportunity for cultural and scientific exchange among secondary school teachers of the Americas.

Science development has been supported through the OAS Program of Direct Technical Assistance. Under this program, expert assistance is provided for periods of approximately three months to advise in the

organization of specialized training in various fields. During the past 18 months, four such Direct Technical Missions have been sent, including one to the Department of Biochemistry of the University of El Salvador to establish a radioisotope laboratory.

Information and symposia.—The need for communication of scientific information is acute in the nuclear sciences because of the great rapidity with which new advances and discoveries are being made, and is particularly important to those countries that are just beginning to support nuclear development. The exchange of information through scientific journals, research and administrative reports and special communications is vitally important. For full exchange of data and explanation of research techniques, and the stimulation of ideas which results from personal contacts, however, it is essential that scientists and other nuclear experts meet periodically to discuss their work.

Before IANEC was formally organized, the First Inter-American Symposium on the Peaceful Application of Nuclear Energy was held at the Brookhaven National Laboratory in May of 1957 by the Government of the United States under the auspices of the Atomic Energy Commission, the Department of State, and the International Cooperation Administration. The formal papers which were presented and the discussions which followed covered the broad spectrum of nuclear science and engineering applications including training and education, the physical sciences, technology, medicine, biology, agriculture, and management problems.

Anticipating by a few months the formal organization of IANEC, the Division of Science Development began preparations for the Second Inter-American Symposium, which was held in Buenos Aires, Argentina, in June 1959 under the joint auspices of the Government of the Republic of Argentina and the OAS with the support of the U.S. Atomic Energy Commission. Various Latin American countries had already made considerable progress in their programs for the peaceful uses of nuclear energy, particularly in applications of radiation and of radioisotopes in basic biology, medicine and agriculture; the program of the second symposium was, therefore, focused upon the life sciences. Invited papers reported both the results of research and information on development and plans.

Approximately 150 scientists from member countries of the OAS attended along with representatives of the International Atomic Energy Agency, the Pan American Health Organization, the United Nations Educational, Scientific and Cultural Organization, and the Inter-American Institute of Agricultural Sciences. The information on research developments and results in the various countries and institutions was thus brought to the attention of the world scientific community and laid the foundations for future voluntary, cooperative research efforts among the individual scientists.

In addition to this formal mechanism for the communication of information, IANEC secretariat supports the expansion of libraries and scientific documentation centers in the hemisphere and acts as the center for information concerning the OAS programs in science and nuclear energy and the developments in the member countries of the OAS.

At its first meeting, IANEC urged all agencies concerned with nuclear energy research to study means by which their technical information services could be expanded and also recommended that

the member states give consideration to the possibilities for eliminating tariff and import restrictions on publications and scientific equipment required for the development of nuclear science.

Liaison and coordination.—In addition to its primary function as liaison and coordinating agency for the development of the nuclear sciences in its member states, the Inter-American Nuclear Energy Commission has recognized the importance of maintaining close relations with other intergovernmental organizations concerned with the peaceful uses and applications of atomic energy. In this the International Atomic Energy Agency is considered to be of particular importance. The Secretariat is presently engaged in expanding its contacts and coordination of programs with the IAEA, Organization for European Economic Cooperation, Euratom and other international agencies and in investigating the steps which may establish stronger relationships with them.

The Secretariat also is in constant and increasing contact with various nonnuclear science agencies of the U.S. Government and private organizations that have interest in Latin American development. Among them are the National Science Foundation, the International Cooperation Administration, the Department of State, the U.S. Information Service, and the National Academy of Sciences. To an increasing extent the IANEC and the OAS are serving as the channel through which aid and assistance are being given by these agencies to nuclear and nonnuclear science development, thus avoiding certain of the difficulties and complications that often arise from independent unilateral agreements. The financial support given by the U.S. Atomic Energy Commission to IANEC for the nuclear energy symposia is an outstanding example of this type of activity.

A few illustrations of cooperative action may be cited as illustrative of the type of activity in which IANEC may be expected to play an increasingly important role.

Now under discussion are possibilities for cooperation between the International Atomic Energy Agency, the Inter-American Nuclear Energy Commission, the U.S. Atomic Energy Commission and the U.S. National Science Foundation in holding a series of library workshops in the acquisition and use of nuclear energy publications. Particular emphasis would be given in these workshops to the efficient use of the "atoms for peace" libraries which have been given to all the countries of Latin America under the President's program.

Established in 1957 by the U.S. Atomic Energy Commission as part of the atoms for peace program, the Centro Nuclear de Puerto Rico of the University of Puerto Rico antedates the organization of the IANEC. Yet in many respects it anticipates the cooperative, regional training centers which may be expected as a result of the Inter-American Commission's primary concern with education and training. The instruction at the Centro is presented entirely in Spanish although many of the activities of the university are bilingual. This is of great importance to the development of trained personnel so badly needed in all the Latin American countries. The programs of instruction include the applications of nuclear science to engineering and courses in radiation physics and safety, but primary emphasis has been placed upon training and research in the applications in medicine and biology.

The Centro is supported by the USAEC and the University of Puerto Rico, but a number of other agencies have made fellowships

for study there available. They include, for students from Latin America, the International Cooperation Administration, the U.S. Department of State, the Organization of American States, the International Atomic Energy Agency, the Institute of International Education, the Pan American Sanitary Bureau, the World Health Organization, and the Rockefeller Foundation. Fellowships for citizens of the United States are granted by the U.S. Atomic Energy Commission and the National Science Foundation.

PAN-AMERICAN HEALTH ORGANIZATION (PAHO)

The Pan-American Health Organization is the intergovernmental health agency for the Americas. The Pan-American Sanitary Bureau is the Secretariat of PAHO. PASB also serves as the regional office of the World Health Organization for the Americas.

The Pan-American Sanitary Bureau (PASB), known until 1923 as the International Sanitary Bureau, had its origin in a resolution of the Second International Conference of American States (Mexico, January 1902) recommending that "a general convention of representatives of the health organizations of the different American republics" be convened. This convention met in Washington in December 1902, and established the Bureau on a permanent basis. The Pan-American Sanitary Code (Havana, 1924), a treaty ratified by the governments of the 21 American republics, assigned to the Bureau broader functions and duties as the central coordinating agency for international health activities in the American Republics. In 1947, the Bureau became the operating arm of the Pan-American Sanitary Organization (PASO), the Constitution of which was officially approved by the Directing Council at its meeting in Buenos Aires later that year. In 1958, the designation of the Pan American Sanitary Organization was changed to the Pan-American Health Organization (PAHO). The name of the Bureau remains unchanged.

Pursuant to the agreement concluded between PAHO and the World Health Organization (WHO) in 1949, PASB serves as the WHO regional office for the Americas. PAHO is also recognized by the Council of the Organization of American States as an inter-American specialized organization with fullest autonomy in the accomplishment of its purposes, which are to promote and coordinate the efforts of the countries of the Western Hemisphere to combat disease, lengthen life, and promote the physical and mental health of the people.

In fulfillment thereof, the Bureau cooperates with member governments in the development and improvement of national and local health services, provides services of consultation, grants fellowships, organizes seminar and training courses, coordinates activities of neighboring countries having common public health problems, collects and distributes epidemiological information and health statistics, and performs other related functions.

In the field of the health aspects of radiation PAHO will assist governments with technical advice through fellowships in two major fields: (*a*) use of radioisotopes for medical research, diagnosis, and therapy; and (*b*) development of procedures and standard regulations for radiation protection, in both the use of isotopes and other radiation sources and in the disposal of radioactive waste from power reactors and other sources. It is proposed to award fellowships for the training of national radiological officers for service with the health departments.

Provision is also made under this project for the use of short-term specialists to advise and assist governments in the development of safety programs for the application of radiation protection procedures, including atomic waste disposal. They would also advise on the drafting of health regulations and laws to provide administrative and legal bases for carrying out protective measures.

C. European Atomic Energy Community (Euratom)

The Euratom Community came into being in January 1958. It comprises Belgium, France, the Federal Republic of Germany, Italy, Luxembourg, and the Netherlands. Its aim is to promote the development of peaceful uses of nuclear energy. The community's executive organ is the Commission, composed of five members with administrative offices located in Brussels. An important function of Euratom is the development of a cooperative research program. A large Common Research Center is being established at Ispra, Italy. Negotiations are in progress for the setting up of smaller centers at Petten, Netherlands, and Karlsruhe, Germany. A Euratom Central Measurements Bureau is located at Mol, Belgium. In addition to the radiation research activities to be carried out at these community centers, the Commission is financing and negotiating research contracts with national research centers and with private laboratories and industries. Listed below are some of the radiation research activities being carried out in Euratom member countries. It is based on incomplete information and is not meant to be exhaustive of this kind of research now being carried out in the Euratom Community; but rather to be illustrative and to report trends in this rapidly developing field.

1. *Radiation biology.*—It is not possible to give an overall picture of the situation because of insufficient data on the number of people engaged in this work and the sums of money involved.

In *France*, the bulk of the research work is done by the Biology Division at Saclay.

The Netherlands is the only country to have a project dealing with fast neutrons. Efforts are concentrated at the Radiobiological Institute of the TNO (Organization for Applied Research) at Rijswijk. The Euratom Commission has concluded with the TNO a research contract in the field of radiobiology. It is scheduled: (*a*) to study the physiology of the medullary graft on mice, rats, guinea pigs (work which is already under way) and on monkeys (a new venture begun after the Commission contacted the TNO); and (*b*) to deal with the question of obtaining and breeding laboratory animals under completely aseptic conditions.

In other countries, research in the field of radiobiology is done primarily by universities and specialized institutes.

In *Belgium*, radiobiologists are particularly active at each of the four universities. The research center at Mol will have at its disposal a reactor, a powerful gamma ray source and all the equipment needed for radiobiological and agronomical research. Radiobiology and radioagronomy laboratories are being constructed and research work already started in 1957 will be continued in the buildings and grounds made ready for use in 1959.

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In *Italy*, the CNRN (National Commission for Nuclear Research) has a "Biology Division" and, attached to it, a "Medico-biological Department" situated at Ispra. They plan a research program in the fields of radiation genetics and radiobiology, the development of which will depend upon the quantities of short-lived radioisotopes made available by the Ispra I reactor. Radiation biology is being studied at a number of universities. The Center for Nuclear Medicine at the Medical Clinic of Rome University is concentrating on the mechanism of biological damage resulting from the effects of radiation. Historadioautography is practiced at the Institute for Pathological Anatomy in Milan, where research work is being carried out on the preservation of the living cell from radiation damage.

2. *Radiation genetics.*—In *France* and *Germany*, a certain amount of research is being done on the genetic effects of irradiation of moderate intensity, with reference to external radiation as well as to radionuclides absorbed by the body.

In *Italy*, the Ispra "Medical and Biological Division" will be drawing up a program of research on radiation genetics in conjunction with the central biological division of the CNRN. The University of Pavia has a Genetics Institute which is carrying out a program of research in this field.

3. *Environmental radiation.*—Measurements of radioactive fallout and dust and water radioactivity have been made in all countries in order to keep a permanent record of the intensity of radioactivity and the concentration of certain radionuclides to which the total population is exposed. Studies have been carried out in *Belgium*, *France* and the *Netherlands* on the dosage of strontium, cesium and other isotopes in the water and soil and in biological matter such as grass, milk and agricultural products.

For this purpose, a certain number of sampling and monitoring stations have been set up in each country. These stations, as of September 1959, were distributed as follows:

Belgium	5
Germany	40
Italy	23
France	26
Netherlands	4
Luxembourg	1
Total	99

Monitoring of radioactivity in the immediate vicinity of nuclear reactors is conducted.

5. *Radiation protection—Preventive and protective measures and safety standards.*—Work is proceeding in the design of equipment for protection against ionizing radiations and, in particular, neutrons; design of equipment relating to the protection of nuclear installations, e.g. reactors, cooling and purification circuits, etc.; design of special equipment, e.g. for handling high-activity, gamma ray emitters (plutonium).

In *Belgium* and *France*, nuclear research establishments are working in cooperation with industry.

In *Italy*, a number of centers are endeavouring to develop methods for providing protection against high-energy radiation, in particular the CNRN, which is assisted by a number of commissions, one of which is concentrating on the study of health and safety questions,

AGIP Nucleare, Bologna University's Institute of Physics, and Turin University's Physical Biology Center, which is studying the prevention and protection aspects of accelerators and reactors and safety standards as applied to them.

On the question of general safety provisions, it should be noted that one of Euratom's first tasks was to lay down basic standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiations; these standards, with which member states are bound to comply, were issued by the Council of Ministers of the Community in February 1959. These standards define the maximum permissible radiation doses and concentrations of certain nuclides, and the measures to be adopted for the medical control of persons exposed to radiations; under article 33 of the Euratom Treaty, member states undertake to enact the legislative and administrative provisions required to ensure compliance with these standards.

Radiation therapy.—The work being done on this subject may be subdivided as follows: (*a*) biological effects of radiation—physiopathology and therapy for radiation sickness of mammals; (*b*) chemical protection against radiation and physical protection of a part of the body; (*c*) restorative processes after irradiation and therapeutical action of spleen and bone marrow homogenate injections made after irradiation; (*d*) basic research as, for example, research on fundamental biological lesions.

Not counting Germany, it can be estimated that a technical and scientific staff of about 70 physicists, chemists, biologists and doctors are engaged on these projects. Of this number, about 15 scientists are working on projects coming under (*a*) about 30 under (*b*) about 10 on (*c*) and about 15 on (*d*). Thus, the bulk of the staff involved is engaged on the projects dealing with chemical safeguards against radiation.

Belgium is most active in this field, under the influence of the Liege School, where the protective effect of cysteamine and cystamine was discovered.

In *Italy*, an active program in the field of biological and medical prophylactic or therapeutic applications is being initiated by the Higher Institute of Health in Rome as well as by clinics and institutes of medicine and biology at various universities. The Institute of Health which employs radioisotopes in its research work on metabolism, and monitors activity and precipitations in the atmosphere, has made a study of protection standards for accelerators and has drawn up a program for research on chemical protection against ionizing radiations. The Study Center for Physical Biology at the University of Turin is experimenting on cystamine as an agent against radiation effects.

According to available information, little work is being carried out on restorative processes, but work is in progress in the TNO radiobiological laboratory at Rijswijk (*Netherlands*), as well as in the *Paris* laboratories which saved the five Yugoslav technicians with bone marrow injections.

Waste management.—Numerous and varied studies dealing with the treatment of radioactive water are in progress in the Community countries. Work is mainly centered on the problem of water decontamination, principally by chemical or physical chemical methods

(entrainment by precipitation and absorption, ion exchange). In certain cases (Marcoule, Le Bouchet, Saclay, Mol), these studies have transcended the laboratory stage and have been put into industrial production on a considerable scale.

At Mol in *Belgium*, CEN's services are equipped with several research laboratories, for treating effluents before discharge into the river; various private firms are also carrying out research on the treatment of effluents.

In *Italy*, one of the research laboratories to be set up at Ispra in the vicinity of the reactor will make a study of this problem. The study of the decontamination of water containing radioisotopes is also included in the CISE research program (Information, Study and Experimental Center). AGIP Nucleare's research work on physical chemistry involves a study of effluent decontamination.

Within the Community, two studies are in progress (*Belgium* and *France*) in the field of gas purification for the removal of radioactive carbon dioxide, tritium, rare gases, elemental iodine 131, and fogs.

6. *Agriculture.*—Primarily in *Germany* and *France*, laboratories are studying the employment of radioelements in agriculture.

In *Belgium*, where a number of private and public bodies are extremely active, a department with all the equipment needed for agricultural research is being built at Mol; radioagronomy laboratories are under construction.

In *Italy*, the CNRN plans to build near Rome a "research center for the applications of radioisotopes and radiations in biology and agriculture." This would include a "gamma field" and a group of research laboratories for studying the application of radiations and radioisotopes in the various fields relating to livestock and agriculture. The gamma field will provide an irradiation surface of 1 hectare and enable studies on low-level chronic irradiation to be carried out over 24 hectares. Initial expenses and annual working costs are estimated at 80 million and 35 million lire respectively. The research laboratories will be divided up into six sections (dosimetry technique, genetics, plant pathology and entomology, livestock research, chemistry-biochemistry-physiology, agricultural and industrial microbiology). Initial expenses for all the laboratories and annual working costs will amount to 420 million and 235 million lire respectively. An Institute for Nuclear Studies in the field of agriculture (INSA), which has been inaugurated in Rome, will carry out development and documentary work on the applications of nuclear energy to agriculture and livestock.

In the *Netherlands*, the ITAL (Institute for the Applications of Nuclear Energy in Agriculture) at Wageningen is building a reactor specially designed for agronomical studies.

7. *Medical application.*—Radioisotopes are in current use for purposes of diagnosis. The most commonly used radioelements are: Iodine 131, which shows signs of being supplanted by I–133, which has a shorter half life, for thyroid studies; P–32 for research on certain forms of bone cancer; Astatine 76 is employed in skin cancer. Radioelements are also widely used for therapeutic purposes. There are some 20 teletherapy units equipped with cobalt 60 sources in the countries of the Community.

To these radiation sources should be added a number of betatrons and other accelerators such as the betatrons in *Italy* at the Institute

of Medical Radiology at Rome University (which is studying the therapeutical applications of high energy radiations), at the Medical Clinic of Turin University (a 31 Mev betatron), the Palermo Cancer Center (a 15 Mev Siemens betatron costing 90 million lire which will be used for stationary and movement therapy), the Cockroft-Walton accelerator at the Higher Institute of Health in Rome and the Van de Graaff accelerator at the Medical Clinic in Bologna; in *France*, the betatrons belonging to the Villejuif hospital and the Health Ministry, the linear, or medium and low energy cavity accelerators at the Anti-Cancer Center in Nancy and the Hospital Foundation Curie in Paris; in *Belgium* betatrons are being installed in various university hospital centers.

Saclay and Mol have sections for the synthesis of organic products which are earmarked for research and therapeutical use.

In certain countries, such as *France* and *Italy*, existing laws allow only a restricted number of bodies to use radioelements in medical diagnosis and therapy. The effect of these measures is to limit the number of users.

8. *Radiation detection and measurement—Development of methods for the absolute measurement of radioisotope activity and for the establishment of standards.*—The development of methods for the absolute measurement of radiation intensity (standard chambers) and for the calibration of dosimeters is the subject of isolated studies. The "measurements" section of the Saclay "electronics" division is building a high energy ionization chamber. This graphite chamber, however, is not used for dosimetry, but for isotope standardization. A "4-pi" counter has just been developed there.

The Max Planck Institute in Göttingen also has a division for radioisotope standardization. For the purpose of enabling the results of its own work in this field to be compared with that being done in other countries, the National Physical Laboratory at Teddington (*England*) reports each year on a certain number of its standards to Saclay and the Max Planck Institute.

Development and use of: apparatus for the measurement of radiation; dosimeters; apparatus for the monitoring of atmospheric radioactivity, radioactive fallout, radioactivity in water and the food cycle; apparatus for contamination control (personnel, walls, etc.).—These studies have been carried out simultaneously with the development of nuclear reactors and radioisotope utilization. Work is being done within the Community in this field and excellent results have been obtained. On the whole, there is very close collaboration between the national nuclear centers and industry. More than 50 industrial laboratories, about 25 in France and 15 in Germany, together with university laboratories and nuclear electronics departments, such as those at Saclay, Mol and Grenoble, are working on the various aspects of detection, counting and analysis.

Research on detection and measurement is in progress in the construction of complex electronic assemblies—such as multichannel analyzers—the transistorization of electronic, more particularly portable equipment, neutron detection as applied to health control, the construction of bubble chambers, the measurement of low activities in effluents and the detection of radioactive aerosols.

9. *Education, training and information.*—Training courses in the radiation aspects of the life sciences are relatively numerous in the Euratom countries, as follows:

Category	Number of courses				
	Belgium	France	Germany	Italy	Netherlands
Radiation biology	1	4	2	6	3
Radiation genetics				1	
Environmental radiation			2		
Radiation protection	3		8	12	1
Agriculture					1
Medical application		1	5	3	
Radiation detection and measurement	1	1	5	11	1

Most of these are university courses of one semester in length (11–15 weeks); a few are 24–36 weeks in length; one at Pavia is four semesters in length. There are a number of courses for training in the use of isotope techniques in research and medicine, of 1–5 weeks in length.

D. European Organization for Nuclear Research (CERN)

CERN was founded in 1954 by 12 European governments (Belgium, Denmark, France, German Federal Republic, Greece, Italy, Netherlands, Norway, Sweden, Switzerland, United Kingdom, Yugoslavia) to assist Europe to attain a first-rank position in nuclear science. The CERN Convention states—

> The Organization shall provide for collaboration among European States in Nuclear Research of a pure scientific and fundamental character, and in other research essentially related thereto.

CERN does not concern itself with research of a military character, and all results are publishable. The laboratories are located on a 118-acre site at the Swiss-French border, 5 miles west of Geneva.

CERN's research efforts have been almost completely limited to physical, chemical, and engineering research. It has not attempted research in the life sciences at the international level but has restricted its interests to answering questions arising from its own needs. Studies in this category at CERN are undertaken exclusively by the Health Physics Group. The group exists with the main purpose of serving the ends of CERN itself, but it has been agreed by the Board of Directors (now the Leading Board) that the Health Physics Group shall cooperate wherever desirable with other national and international organizations. From time to time the health physicist has sat on international committees in the capacity of observer or adviser.

1, 2. *Radiation biology and genetics.*—At present no program of biology is carried out at CERN, although it will not be precluded from future plans.

3. *Environmental radiation.*—In view of the recommendation of the International Commission on Radiological Protection that the dose received by persons living near establishments such as CERN shall not exceed 500 millirems per annum, some studies of the environmental situation are being carried out. The measurements are facilitated by a mobile laboratory having its own power supplies and equipped with suitable sensitive measuring equipment including

both Geiger-Müller counters of the type used in several British surveys, and large high-pressure ionization chambers.

5. *Radiation protection.* (a) *Medical.*—The medical supervision of CERN staff exposed to radiation is entrusted to specialists holding appointments in the University of Geneva, and a close liaison is maintained with the Service de Controle des Irradiations, in order to build up archives which may be useful in studies of long-term effects of low level chronic irradiation.

(b) *Radioactive waste disposal.*—The levels of radioactive waste encountered at CERN are extremely low and no problems have been encountered, nor is any research into waste disposal methods foreseen.

(c) *Shielding.*—No systematic study with shielding problems is made but considerable experience exists and is drawn upon for the solution of individual problems as they arise.

8. *Radiation detection and measurement.*—Many of the dosimetry problems at CERN are unusual partly because of the high energy of the machines, (600 Mev [2] cyclotron, 25 Gev [3] proton synchrotron), and partly because of the pulsed nature of the radiation encountered. Studies have been made of the permissible fluxes of very high energy particles and considerable effort has been made in the development of suitable measuring instruments. The effort has been restricted to external radiation and no attempt has been made to develop new instruments for the detection of radioactivity, either in materials or in the human body.

No studies are being undertaken in the categories of toxicology, agriculture and medical applications.

E. Organization for European Economic Cooperation (OEEC)

European Nuclear Energy Agency (ENEA)

European Productivity Agency (EPA)

OEEC came into being with the signing of the Convention for European Economic Cooperation in April, 1948. It comprises the following member countries: Austria, Belgium, Denmark, France, Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and the United Kingdom. The United States and Canada are associate members. Yugoslavia is represented by an observer and participates fully in the work on agriculture and food. Headquarters are in Paris.

The European Nuclear Energy Agency (ENEA) was established in December 1957, within the framework of the OEEC, to further the development of the production and uses of nuclear energy for peaceful purposes by the OEEC and its member countries. The protection of public health is one of the tasks with which ENEA is specifically charged and, for this purpose, it has set up a Health and Safety Subcommittee, composed of representatives from all Member countries. The members of this subcommittee have high responsibilities in the field of public health and safety and radiation protection in their respective countries. The subcommittee acts as an advisory

[2] Mev: Million electron volts.
[3] Gev: Thousand million electron volts.

and consultative body to the Steering Committee, to which it submits recommendations for joint actions in this field.

ENEA has no direct responsibility for conducting research, but is concerned with the elaboration of recommendations to Member countries, compilation and evaluation of work carried out in individual countries and the exchange of the results of such work.

The European Productivity Agency (EPA) was set up as a branch of OEEC in May 1953, to stimulate productivity, and thereby raise European standards of living, by influencing governmental, industrial, agricultural and research organizations, private and collective enterprises and public services.

The activities of ENEA and EPA fall into the following categories of this report:

5. *Environmental radiation.*—ENEA has established a system for a regular and coordinated exchange of information on environmental radioactivity, based on data provided by member countries. This exchange is effected through the regular dispatch by member countries of official reports giving the necessary data to allow ENEA to draw up periodicial surveys for distribution to the competent authorities in member countries. The system is already in operation for studies of airborne radioactive material and will include studies on settled radioactive material in precipitation and dust and, in particular, certain radioisotopes contaminating food, milk and drinking water. Furthermore, ENEA has carried out and published an analytical survey of the existing stations and methods for measuring environmental radioactivity in OEEC countries. The Agency is also working out a system whereby in the event of any important increase of radioactivity in any one OEEC country, the other member countries would be informed immediately.

6. *Radiation protection.*—By a Council Decision of June 1959, the OEEC countries have undertaken to ensure by appropriate measures adequate protection against the hazards of ionizing radiations for the general population and for persons occupationally exposed. They have likewise agreed on necessary measures to meet emergency or accidents involving ionizing radiations. Earlier this year ENEA, in collaboration with Euratom, drew up radiation protection norms, based on the recommendations of the International Commission of Radiological Protection. These norms cover persons occupationally exposed to ionizing radiations, special groups of the population and the population as a whole, and give the maximum permissible exposure and maximum permissible concentrations of radioactive isotopes in drinking water and air.

7. *Agriculture.*—EPA attempts to acquaint member countries with the possibilities offered through the application of atomic science to agriculture and food, and has promoted closer cooperation between European countries and the United States on the subject. Four U.S. consultants were employed to advise on planning and to stimulate cooperation in research at the national and international levels. Their studies led to a European Working Conference in 1958 which reviewed developments in the application of atomic science to agriculture and food, including economic implications in soil and plant science, animal science, plant genetics and food preservation. In addition to the report of the Conference, EPA has published a compilation of laboratories and scientists doing work in these four

fields, in each member country. EPA has recently, in cooperation with the "Centre d'Etudes Nucléaires de Saclay", France, created a European Information Center for Food Irradiation which issues a quarterly international newsletter. In collaboration with EPA, ENEA has set up a Study Group on Food Irradiation, which is examining the national food irradiation programs with a view to international cooperation in this field.

8. *Radiation detection and measurement.*—Problems connected with the detection of certain radioisotopes and the measurement of radiation in the field of environmental radioactivity are under discussion, and recommendations are being worked out by the Health and Safety Subcommittee of ENEA.

9. *Education, training and information.*—ENEA organizes periodically special scientific conferences and symposia. In cooperation with the Danish Atomic Energy Commission, it organized a symposium on technical methods of health protection in atomic energy installations (radiation protection, control of radioactive contamination, emergency measures), which was held at Risø (Denmark) in May 1959. In the field of education and training, ENEA arranges a number of special international courses at nuclear centers in member countries covering all aspects of nuclear science and engineering.

Collaboration with other international organizations.—ENEA is expressly bound by its statute to take account, in the performance of its duties, of the work done by other international organizations concerned and to request their cooperation as far as possible. Among the organizations with which liaison has or is being established are IAEA, Euratom, WHO, ILO, FAO, and UNSCEAR.

Part 5

TENTATIVE FINDINGS

As stated in the introduction, these findings are presented by the chairman of the subcommittee, based upon his review with the project director. The findings have been submitted to other members for their information and are believed to be representative of the judgment of the subcommittee.

Nevertheless, the findings are not presented as yet as definitive conclusions, since the subcommittee, as a matter of policy, has decided to refrain from the formal expression of its joint opinion, pending completion of this entire series and issuance of the final report.

The findings are of a twofold nature. They concern—

(*a*) the magnitude and framework of international radiation research

(*b*) problems of information-management and coordination on the research. Each of these categories will be considered in turn.

1. Findings on Magnitude and Organization

The wealth of information which has been developed herein by the Atomic Energy Commission with the cooperation of U.S. and foreign sources confirms this basic fact:

Radiation research in the life sciences is being carried on by dedicated scientists in a farflung system of organizations and facilities throughout the world.

The immense opportunities for good, based upon this research, have been confirmed by so many expert sources that they do not need reiteration here. Similarly, the challenge for avoiding harm through the findings of such research has likewise been so repeatedly stressed as not to require elaboration.

The subcommittee has, in any event, established what we believe is a significant "baseline" on the organization of this international effort.

A. CONSIDERABLE MAGNITUDE OF RESEARCH

A baseline has been established as regards the statistical dimensions of the research as well. The magnitude of radiation research in the life sciences is large and is growing larger. It embraced in 1959 an estimated 3,362 projects in 9 major fields throughout the world, involving an estimated $101 to $111 million.

The summary table shows an expenditure within the United States of approximately $63.4 million for radiation research and training in the life sciences. Major programs in other countries, exclusive of U.S.S.R., expended $7.6 million as reported.

It is unlikely that nonreported funding of other foreign programs would bring this total much in excess of $8 million, or around 12 percent of the U.S. expenditures. Contributions of the United States to the foreign total are negligible.

Expenditures of technical manpower are in somewhat the same ratio (U.S. reports are in terms of man-years, while foreign reports, particularly the French, are to a considerable extent in terms of numbers of persons involved regardless of the amount of their investigative time).

No data are available on the investment by U.S.S.R. of funds for radiation research in the life sciences, but on the basis of a total budget of $1.1 to $1.6 billion and the number of scientists involved, as compared to the U.S. investment, it might be estimated that U.S.S.R. expended in 1959, $30 to $40 million on such research and training.

B. VOLUME AND DIVERSITY INVOLVE ISSUE OF COORDINATION

A multiplicity of nations and organizations are involved in the worldwide research efforts. This considerable number appears to merit the subcommittee's note on the importance of international and interagency coordination. Inevitably, a vast number of facilities and institutions are involved. Thus—

(*a*) ten U.S. agencies (including the quasi-official National Academy of Sciences-National Research Council) are engaged in this research directly and indirectly;

(*b*) sixteen U.S. voluntary health agencies and private foundations are supporting some 50 projects, aggregating $540,000;

(*c*) nine other nations of the free world are known to be engaged in an estimated 942 projects, aggregating $7,667,000;

(*d*) the Soviet Union's effort aggregating $30 to $40 million, sizable in itself, is supplemented by an unknown amount of activity within Soviet bloc countries;

(*e*) the International Atomic Energy Agency is engaged in 48 projects, involving $309,000.

Vast contribution of Atomic Energy Commission

Concerning the U.S. Atomic Energy Commission, its own research effort is vast and significant.

In all the world, it is the largest single source of support of radiation research. Under its auspices, 1,027 projects are taking place, involving $47.4 million, 2,085 man-years of principal scientists' and 2,389 man-years of supporting scientists' work.

These projects are underway in four different categories of institutions:

(*a*) principal onsite facilities;
(*b*) secondary onsite facilities; and
(*c*) U.S. offsite facilities;
(*d*) foreign offsite facilities.

The last-named category is of special interest to this subcommittee in terms of its international focus. In 1959, the AEC's foreign offsite facility program was conducted through 10 contracts with university and other research stations in seven foreign countries and Puerto Rico. These contracts aggregated $202,000.

C. QUESTIONS OF MAGNITUDE AND DISTRIBUTION

A number of questions may arise in the mind of the reader. Is the present magnitude of U.S. and foreign research effort in the life sci-

ences adequate? Is it in proper proportion to the research effort in the physical sciences? Is the distribution of the effort appropriate, both as between the various categories of projects in the life sciences and as regards institutions and facilities conducting the projects?

All of these questions are within the province of the Joint Committee on Atomic Energy and have been the subject of continuous expert review since enactment of the first law on atomic energy.

It would be neither appropriate nor feasible for this committee to comment on any of these questions.

Having assembled the data on magnitude, organization and distribution, we feel that we can now turn to that phase of the findings which does lie within our jurisdiction—the interagency and international management of information on these research projects.

Thus, the following findings are presented in more detail than the findings on magnitude because it is with respect to this information phase that this subcommittee can most expertly address itself.

2. Findings on Information-Management

Within this category of findings, the chairman of the subcommittee draws upon—

(*a*) the experience of the Atomic Energy Commission and of other Federal agencies in compiling this data;

(*b*) other agencies' experiences in compiling at our request, other data in biomedical research;

(*c*) a large volume of observations by the subcommittee on problems of information-management and research coordination.

What, it may be asked, does the variety of data from sources (*a*), (*b*) and (*c*) above suggest as to the status of information-management on the $100 million of radiation research projects in the life sciences, as outlined in this report?

The data suggests that a serious problem exists on national and international information-management on current research projects.

This problem vitally affects the task of sound planning and coordination of research itself, in the judgment of the chairman of the subcommittee.

To what degree, it affects this task would be difficult to say. To determine the answer in great depth, would require an authoritative review which would be difficult, complex and technical. It could only be based on exhaustive study. Such a study by our subcommittee within the time and resources available is not feasible. A more appropriate and expert source would be the Joint Committee on Atomic Energy.

What then may we say in detail on present information-management and coordination?

A. Standard Channels of Communication

Concerning the large volume of on-going research, the scientific community of the world fortunately possesses and utilizes important channels of communication. While some problems of classification of certain data obviously exist, local, national and international scientific organizations hold many meetings at which exchange of data takes place, both formally and informally. Technical reports and

articles in journals flow in the international stream of communications within and between the nations. Personal visits take place.

Within our own and within other nations, scientists work on a wide variety of study groups, panels and committees of an advisory, interdisciplinary, interdepartmental and international nature. All of these and other mechanisms and procedures contribute to the goal of coordination which the subcommittee stresses.

How well this coordination actually achieves its goal within the United States and between the United States and foreign sources could only be ascertained by the most detailed-type technical evaluation. This subcommittee would not presume to attempt such evaluation.

B. THE INFORMATION-MANAGEMENT PROBLEM

Are we then to conclude, from the evidence, limited but significant, which we have compiled, that we generally can take confidence in the degree of coordination to date? The answer, we respectfully submit, is at least partially in the negative.

Our evidence leads us to believe, as indicated hereinbefore that deficiencies in information-management do contribute to deficiencies in coordination.

It must be reiterated that we express this judgment only on the basis of our review of one phase of the problem involving the management of information—namely, managing and utilizing data on current research. By this we refer to the challenge of maintaining adequate knowledge of—

(*a*) the very existence of specific projects within the large volume of on-going research; and

(*b*) the results generated by these projects once they are completed, in whole or in part.

The above pose two different problems. Admirable progress has been made on the second problem, documentation; far less on the first one, on-going research in its prepublication stage.

C. STRENGTH OF AEC INFORMATION SYSTEM

The Atomic Energy Commission has an advanced system for storage and retrieval of technical information. See article, "New Indexing Pattern for Nuclear Science Abstracts," by Melvin S. Day and Irving Lebow in "American Documentation," Vol. XI, 1960. Another description of the AEC system (including commendation of it) is found in the report, "Documentation, Indexing, and Retrieval of Scientific Information," as published by the Senate Committee on Government Operations (pp. 15–16 and 35–53–S. Rept. No. 113, 86th Congress).

One of the most useful elements of the AEC's system is its elaborate program for dissemination of *progress* reports (pp. 45 ff. of this committee's report on "Documentation").

With regard to international distribution of data, this fact may be stated with confidence:

No nation in the world has made available more documentation than the United States on radiation research in the life sciences. No government agency anywhere has made available more data on this subject than has the Atomic Energy Commission. It furnishes, for example, to 160 depository libraries in various nations of the world

research and development reports together with abstracts, journals, films, and other informational material in the general area of medical and health-related activities.

Time gap regarding data on new projects

The principal finding by this subcommittee is that all new radiation research projects are not at present promptly and centrally registered in a way which permits easy and frequent access to descriptive (rather than merely administrative) data.

The significance of this delay in registration can best be understood in terms of the crucial nature of the time factor. Days, months, or years should not be lost before scientist A can, if he wishes, reliably find out about current work of scientist B or agency A about related projects supported by agency B.

Time is of the essence in communications. To find that information is relatively stale proves frustrating, to say the least.

The key word, therefore, is "current"—i.e., information on research now in process. Why? Because no one knows when this current research will reach publication form, if ever. The research may, as everyone realizes, ultimately yield positive or negative results. No one can accurately predict, for that is the dilemma of experimenting in the unknown.

The fact that a particular hypothesis is being tested is, of course, but a "lead." No one wishes to jump to premature conclusions. There is no sound substitute for scientific method—for orderly experimentation involving painstaking preparation of findings.

But meanwhile, decisions elsewhere have to be made—decisions as to various alternatives of new research, involving more man-years and resources. And it is these decisions which should be based on readily accessible records as to who is doing what or attempting to do what and where, and how much effort and resources are being committed elsewhere to particular concepts and techniques.

It is not enough that a budget office know (as it does know) how resources are being generally allocated. That is not in question in this print. What is before us is the matter of scientists', particularly senior scientists at planning echelons, knowing that a given hypothesis is now being tested in a given way by one or more individuals or groups at particular institutions, rather than such scientists having to wait years to find out about the very existence of an experiment. With specific knowledge of a current project can come improved communication. Without knowledge, how can A be relatively sure of being able to locate and contact B for optimum exchange of ideas on related interests.

We must remember that there are thousands of A's, B's and C's. The day is long past when a scientist could be sure of personally knowing everyone in his own field, much less fields impinging on his own. It is records that must be available—accessible records of fully registered projects.

The fact remains that there is an important time period during which there is significant lack of available information—on work in a considerable number of AEC-supported institutions—the period from date of approval of a new research project in AEC onsite laboratories to date of receipt and publication of the first progress report.

In effect AEC's system, apparently, is geared to store and retrieve information which has already reached publication form, including

a progress report, rather than information as regards current relatively "nonreported" research projects in the life sciences. Of this finding, the AEC itself is well aware.

If proof be needed, it is a fact that it required much diligent effort on the part of a skilled AEC expert to pull together widely scattered information as regards current research projects. Difficulty was apparently experienced even in deriving from AEC's own voluminous files information on its various decentralized programs. Difficulty was likewise experienced in compiling from other agencies' files data on their current activity, notwithstanding the fact that other agencies offered full cooperation.

When it came to obtaining information as regards current research supported by some other countries, infinitely greater difficulty was experienced, including partial failure. Despite considerable effort, this report contains inadequate information as regards any current radiation projects in the life sciences which may be carried on in certain key and free countries of the world.

D. ROLE OF BIO-SCIENCES INFORMATION EXCHANGE

The situation poses a particular problem as regards the lack of readily accessible information on Federal agencies' own programs.

Within the Federal Government, the Bio-Sciences Information Exchange of the Smithsonian Institution has been the clearinghouse designed to contain information on the support of research on a national basis by public and private agencies reporting to it.

This clearinghouse is, in the judgment of the chairman of the subcommittee, a unique and indispensable arm of the Federal Government's research establishment and of science in general.

The subcommittee inquired of the Exchange as to the volume of radiation research projects reported within its files.

E. GAPS IN COVERAGE BY CLEARINGHOUSE

The Exchange reported that the magnitude of radiation research was $16 million for the 1959 fiscal year. Here we note an important and crucial disparity—one well familiar to the AEC. The disparity is between—

(*a*) the 2,036 research projects within the United States, aggregating $63.4 million as reported within this report, as compared with

(*b*) the much smaller number of projects, aggregating $16 million which was reported to the Bio-Sciences Information Exchange.

Only the smaller sum was "reportable," because the Atomic Energy Commission has not thus far required all project information to be reported to it in a way that it could (*a*) maintain the information readily accessible within its Washington Headquarters and (*b*) report to BSIE.

The information is definitely present in the AEC's files, but, in effect, not in immediately usable form.

What does this in turn mean?

It means that because the information—notably from onsite laboratories—is not readily and immediately accessible, it is not used to

anything like the degree it might be used by both the AEC and other Federal granting and reviewing agencies. And because it is not used, the chairman of the subcommittee questions whether the planning and coordination of research on an intra- and interagency basis have attained anything like the efficiency which they should attain.

In effect, there is at present no central source through which any given granting organization or any individual U.S. scientist can find out promptly and reliably about what is at least temporarily $47 million of "nonreported" research. Instead, the organization or scientist would have to go to the many sources which the Atomic Energy Commission had to consult when it sought to fulfill this subcommittee's particular request.

It should be pointed out, in all fairness, that the Atomic Energy Commission is currently finalizing arrangements whereby its farflung "onsite" research organization will be supplying information to it, with the data likewise being made available promptly to the Bio-Sciences Information Exchange. In this way much of the gap of insufficient information will be bridged.

F. GAP WILL PERSIST ON FOREIGN-SUPPORTED PROJECTS

However, it remains of concern to the subcommittee that there will still remain enormous gaps of lack of information, both foreign and domestic. For example, there will still be unavailable to any granting organization in the United States and abroad and to individual scientists, easily accessible knowledge of current research efforts by agencies, notably the U.S. Department of Agriculture, which do not register projects with BSIE.

In addition, there will still be gaps as to the current research effort by foreign-supported sources.

According to the Atomic Energy Commission, foreign nations outside the Soviet Union are currently supporting 942 projects and the magnitude of cost is $7.6 million. Yet there will remain no way by which knowledge about these 942 projects can become promptly available.

The subcommittee understands that one nation is making efforts to organize its knowledge on its own projects in a way which might prove useful to inquiring sources. The subcommittee further understands that this advance may be attributed, if only in part, to the fact that this subcommittee submitted the request for information from that and other nations.

A question persists as to a lack of information on additional nations' activity within the free world.

It is a source of concern to the subcommittee that so many nations of the free world have not for one reason or another made available more detailed information to the Atomic Energy Commission and thereby to this subcommittee.

The subcommittee realizes that the fact that data has not been forthcoming from a nation should not be interpreted as necessarily indicating that a nation is unwilling to supply it. On the contrary, in most instances the reason for nonreporting is merely that the country has not organized its files of information in a way which would readily yield such information. Many nations obviously do not regard

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the availability of such current information as being as significant as this particular subcommittee regards it.

G. TRADITION OF DISSEMINATION OF INFORMATION IN UNITED STATES

A fact which should be borne in mind is that in few, if any nations of the world more than our own, is the dissemination of technical information by Government so strong a tradition and practice. We in the United States believe that it is a definite responsibility of Government to inform its scientists and its citizens in strong and continuous measure.

The fact that there are exceptions to this tradition and practice should not obscure the custom which we Americans have generally come to expect.

We must understand therefore those differences which exist between our own traditions and those of other free governments. The latter have, moreover, differing concepts as to proportions of money and effort which should be spent for purposes of dissemination of information, not to mention differing capabilities for such spending.

H. RESPONSIBILITY OF INTERGOVERNMENTAL ORGANIZATIONS

Nonetheless, it is a cause for concern that intergovernmental organizations do not appear to have available even minimal pertinent information as to individual foreign nations' current efforts. If these intergovernmental organizations do not regard compilation of such information as a high priority, we question exactly what would constitute a higher priority. We do not profess to be technically qualified to judge all of the programs of these intergovernmental organizations. We submit, however, that in our judgment this type of information is of the highest importance and should long since have been requested at least by IAEA.

How can the world scientifically direct its research to highest priority areas; how can it fill recognizable gaps, if it does not have available a far higher proportion of data as to current research?

The subcommittee is cognizant that remarkable cooperation on research in radiation has been manifested by the nations. Many of the nations from whom information for this report was unavailable, have been among the most cooperative.

Yet the information gap persists. It is a gap which entails an unknown number of months or years before even the most elementary information about a given project may become available, if ever. That is the heart of the problem. It is a nub of the limitation on effective scientific communication and cooperation.

I. RELATIVE ABSENCE OF SOVIET AREA DATA

A different category of "missing" information concerns the research effort by the Soviet Union and by nations aligned with it.

The Atomic Energy Commission estimates that the U.S.S.R. may be supporting radiation in the life sciences in a magnitude of $30 to $40 million.

A limited number of reports on radiation research in the life sciences have been filed with the United Nations Scientific Committee on the

Effects of Atomic Radiation by the Soviet Union, Poland, Rumania and Czechoslovakia. Yugoslavia has also made available some data.

The release of more Soviet area and Yugoslav information would appear desirable in the interest of science. Certainly, the Soviet Union's own program would appear to be of such dimensions and significance as to merit much larger and more current availability than the world's scientific community has benefited from to date. Data from the Chinese Communist Government might also be expected by the world's scientists in view of claims made by that Government as to its nuclear activity.

But so far as the U.S. Government is concerned, it can at the least address itself to its own opportunities and challenges.

J. REMEDYING PART OF THE GAP

The phase of the gap which presumably will be easiest to remedy concerns projects supported by the AEC in its own on-site laboratories. The on-site laboratories have traditionally worked on a decentralized basis.

This has been a matter of high policy which the subcommittee does not presume to question, for there are many complex and technical phases in it.

The decentralized laboratories reportedly have been disinclined to furnish project-type breakdowns of a detailed nature to AEC Headquarters; they have preferred to furnish merely the program information. The result has been that the AEC does have a vast amount of data on all the work being carried on in the laboratories, but this data has not been available in as flexible and usable a form as would permit detailed consultation by the AEC or any other granting source.

K. COMPETENT SCIENTIFIC WORK BY AEC

How then has the Commission been able to come to its decisions to support given projects of radiation research under the Division of Biology and Medicine?

The answer is by the same review techniques which are followed elsewhere in the Government, namely, by utilizing (*a*) standard methods of preliminary scientific communication referred to on page 137, and (*b*) the expert services of what the Commission believes to be the most knowledgeable individuals in Federal service and in private life, to review applications. These individuals are presumed to have as current and complete knowledge on radiation projects as is possessed by virtually any other body of experts in the United States.

We do not for one moment doubt the competence of the Commission's officials, staff and consultants. We have every reason to believe that they are indeed what they are represented to be, an outstanding group of skilled scientists.

The chairman of this subcommittee personally believes that it should be a source of pride to every American that the U.S. Government has mobilized so creative a team for research of such worldwide significance.

L. IMPORTANCE OF COMPLETE, ACCESSIBLE RECORDS

The chairman questions, however, whether it is within the capability of any group of scientists to retain—solely within its own recollection,

i.e., not through readily accessible records—the necessary mass of information on hundreds upon hundreds of current research projects at home and abroad.

If detailed records are not available, what may the scientists call upon in a meeting when they are to decide upon new project grants? They may call only upon incomplete records and upon fragmentary recollections. The latter consist of scraps of information which they have read in reports, in journals, in correspondence or which they recall from personal visits, from attendance at seminars and other meetings and from their general knowledge of the state of the art. It may be granted for the sake of agreement that if any group of scientists can make sound decisions on the basis of limited records and fragmentary recollections, the Federal agencies' expert scientists can. But that is a big "if."

Involved, after all, is the task of trying to assimilate a tremendous mass of data on, as we have seen, $47 million in temporarily "non reported" U.S. projects alone. Even if the human mind were capable of storing and retrieving such information, it could not analyze it in a way which would appear adviseable.

In point of fact, the chairman of this subcommittee does not believe that even if the most minute and thorough records were now available, completely cross indexing research everywhere in the world, that this would necessarily in and of itself assure sounder decision in either applying for or making grants. The fact is that records do not coordinate; it is men who coordinate. No record or record system is a substitute for the human intellect. But that is no reason why reasonably complete records should not be readily available, at least as tools.

A special value of records on current research projects is that they represent an invaluable source for possible future data on negative findings. Such findings may never otherwise become generally available to science. No scientist need be reminded of the value of becoming aware of other scientists negative results.

M. THE MANY GROUPS INVOLVED

This overall information problem confronts not only—

(*a*) AEC Washington headquarters and

(*b*) the central offices of all the Federal granting agencies, but

(*c*) all the official, decentralized granting sources throughout the United States and

(*d*) the individual scientists, wherever they may be, who must first decide upon a particular project before submitting an application.

The question is: do not virtually each of these groups and individuals need more information readily accessible as to "who is researching, what and where?"

Would not each of these sources be in a far stronger position to come to sounder decisions if such data could be available?

Would not the advantages of having the data available outweigh the cost of making it available?

These are questions worthy, the chairman feels, of serious consideration.

It is to the good fortune of the United States and of science in general that the AEC has given extensive consideration to these questions.

N. COMMENDATION OF AEC REVIEW

The AEC is taking substantial steps to meet at least part of the problem. Some steps, e.g., as regards certain international phases, are beyond its immediate control.

The AEC has been a very active contributor to and user of the Bio-Sciences Information Exchange. The Deputy Director of its Division of Biology and Medicine has served as a Chairman of BSIE's Governing Board. He and the Commission, according to reports received by the subcommittee, have been forces for strengthening the Exchange by increasing its coverage and its utilization.

The challenge herewith outlined nonetheless continues. It is a challenge involving, in part, how to obtain optimum value from every U.S. tax dollar spent for research. But, far more important, it involves a critical dimension of time in facilitating the discovery and dissemination of data affecting the well-being of all mankind.

A new opportunity has been provided by the formation in September 1960 of the Science Information Exchange (which reconstitutes the former Bio-Sciences Information Exchange by providing for the first time the registration of current projects in the physical sciences as well).

O. PROBLEM EXISTS IN OTHER FIELDS

The twofold problem, of (*a*) insufficient coverage of current research projects, and (*b*) a consequent limitation on planning and coordination, is by no means limited to the radiation field. It is a "twin" problem which the subcommittee has found in virtually every field of biomedical research, as the subcommittee will point out in a later publication.

Mention of this problem within this particular report has only been made because, in our view, it would have been incomplete merely to report a mass of facts on current projects without commenting on the difficulties of the compilation process and the significance of these difficulties.

The chairman of the subcommittee confidently believes that the AEC is on its way to overcoming some of these difficulties.

It is his hope that by these observations, further impetus may be given toward facilitating the AEC's efforts in cooperation with other sources at home and abroad.

P. THE OBLIGATION OF FOREIGN NATIONS

It must be remembered that foreign nations other than the U.S.S.R. are conducting an estimated 942 research projects aggregating over $7.6 million. To this must be added the estimated 336 projects and $30 to $40 million of expenditures by the U.S.S.R. as well as the work of the International Atomic Energy Agency.

The question may be asked: "to what extent are the scientists in these various foreign nations informed as to ongoing research elsewhere in the world?"

The answer can only be that there is no current international clearinghouse provided by the International Atomic Energy Agency or by any other source on foreign and U.S. research.

So far as current research projects within the United States are concerned, it cannot be presumed that any foreign source knows more about them than does the U.S. Atomic Energy Commission itself.

If, therefore, despite its own prodigious effort, the Atomic Energy Commission does not have readily available complete information as to all of the current diverse projects within the United States, foreign countries face even greater difficulties in informing themselves regarding our preponderant share of research.

This in turn means that they cannot bring to their decisionmaking process on future projects as much insight as would appear desirable in the common interest.

Here, therefore, is a subject which commends itself to foreign nations and to intergovernmental organizations. All nations, it must be stressed, share responsibility for wise decisions in this field.

The U.S. Government has taken on tremendous responsibilities in radiation research, but officials of our Government would be the first to affirm the community of interest and obligations everywhere.

The relative magnitude of any nation's research is no index of the caliber of the work of any or all of its scientists. We in the United States esteem the scientific capabilities of men of achievement everywhere. It is because we do not underestimate the value of a single scientist and a single project anywhere in the world that this much attention is devoted to this subject of worldwide communication of data on prepublication research.

But we do not underestimate our own U.S. research.

The fact that certain deficiencies in the communications process are pointed out herein, affecting U.S. agencies, should not obscure the fact, mentioned earlier, that no nation in the world has more research results to communicate nor has done more to communicate those results than has the United States.

The fact that we are eager further to perfect the process as regards information on current research does our Nation honor, in the judgment of the subcommittee.

Q. HEARING ON INTERAGENCY COORDINATION

On August 11, 1960, the subcommittee held a hearing on problems of Coordination of Federal Activities in Biomedical Research. Nine Federal agencies were represented, including the AEC. A broad spectrum of problems was discussed. Central availability of information on radiation research, in particular, was briefly touched upon, and there was agreement on general objectives.

R. CONCLUSION

The subcommittee's chairman concludes that the AEC and all other interested sources, including the Department of State, should press unrelentingly ahead toward resolving this problem of communication, information and planning in international radiation research.

At stake is increased scientific efficiency and acceleration of the momentum of discovery in countless phases which may protect the human race, help heal its ills, help multiply its resources and serve its well-being.

Exhibit A—Form by which the subcommittee invited cooperation in compiling this publication

The following is the text of the outline furnished to cooperating agencies at the time the subcommittee invited their assistance.

1959 OUTLINE

NOTE.—There follows a revision of an outline of a proposed committee print on "The Organization of Radiation Research for the Life Sciences: National and International Activities."

Included in this outline is a group of background notes to cooperating agencies describing the type of material contemplated under each heading.

OUTLINE OF COMMITTEE PRINT

FOREWORD

PART 1. SIGNIFICANCE AND SCOPE OF THIS STUDY

This part will indicate that the print seeks to convey a comprehensive outline and summary of the organization and scope of present U.S. and international efforts, public and private, exploring the beneficial and harmful effects of radiation, as it impinges upon the life sciences.

Purposes

(a) To document—

(1) the current responsibilities, functions, and activities of research-conducting agencies and organizations;

(2) the existing purposes, resources, and scope of present research programs.

(b) To make suggestions, where feasible, for improved coordination of certain efforts which are supported in whole or in part by U.S. official funds.

Part 1 will also indicate that the print does not attempt to review substantive areas of policy questions which are, more properly, within the jurisdiction of the Joint Committee on Atomic Energy or the Senate Committee on Labor and Public Welfare.

PART 2. SUMMARY PRESENTATION

This part will be summarized by the committee staff and consultants, from data and compilations provided by the various cooperating national and international agencies and organizations.

It should be noted that the Senate Committee on Government Operations through its Subcommittee on Reorganization and International Organizations seeks basically to document who (that is, which agency) generally is doing what, where, how, with what resources and with what relationships to that which is being done elsewhere. It seeks the "big picture," rather than the minute details of substantive operations. For clarity as to inter-relationships, it will compile both charts and texts.

This part will, therefore, summarize the "big picture."

PART 3. INDIVIDUAL AGENCY PRESENTATIONS OF PROGRAMS

It is for this part that the various agencies are asked to compile reports.

Summary of what is being asked

Each agency is requested basically—

(a) to fill in appropriate entries under two tables: A and B, described below,

(b) to append descriptive data, under table B, similarly described below.

Style of descriptive data

The descriptive data, following table B, should be presented in a uniform manner suitable for publication in this part, without need for further editing. The style should be appropriate for the intelligent lay reader. It should be generally nontechnical and severely edited—that is to say, short sentences concisely constructed, and omitting insofar as possible the specialized jargon of governmental departments and of scientific disciplines. It should be written in the "third person."

Contents to be included

Included in this part will be the listing and organization of research—both basic and applied—which is being conducted to explore the beneficial and harmful effects of radiation on the biosphere. Clinical research and training in biomedical phases of radiation are to be included, where the term "clinical research" refers to the diagnostic and therapeutic use of radioisotopes and teletherapy units, and of radiation from accelerators (cyclotrons, betatrons, linear accelerators, etc.), reactors and various types of critical assemblies. It does not refer to clinical research with conventional X-ray units. In some cases, an arbitrary decision may have to be made as to whether some particular high-voltage X-ray unit is "conventional" or not. If the device and its application seem unique, the study should be included—otherwise it should be omitted.

One additional type of research which should be included would be studies of incidental effects of X-ray treatment such as genetic, leukemic, etc.

Also included should be statistical and budgetary information pertinent to the needs of the committee in its coordinating, budgeting and accounting responsibility.

Contents to be excluded

Excluded from this part will be the listing and organization of programs and projects primarily of industrial and military character.

Data sought from agencies

Each agency is requested to present its program from the point of view of *What, Who, Where, When, Why,* and *With what significance.*

These are explained as follows:

Format of nine categories of research

What? The research program should be set forth (in the table and in the descriptive paragraphs which follow) under the nine categories described in appendix A. It is not necessary to distinguish between basic and applied research, but consideration must be given to the term "radiation research." It is not desired to prepare a general compendium of all the biological research going on in the world which uses radioisotopes simply as a tool or tracer. Consider that the purpose of this compendium is to explore the beneficial and harmful effects of radiation on living systems and on molecular systems important to life. Hence, if the purpose of a piece of research is to help elucidate these effects, whether the research uses radiation directly or consists simply of a study of normal processes, the research should be included in the compendium.

Information on radiation research and training in the biomedical field should be compiled by each agency or organization according to the following categories which are defined in more detail in the attached sheet (app. A):

(1) Radiation biology.
(2) Radiation genetics.
(3) Environmental radiation.
(4) Radiation toxicology.
(5) Radiation protection.
(6) Agriculture.
(7) Medical applications.
(8) Radiation detection and measurement.
(9) Education, training and information.

All projects should be arbitrarily classified under these nine categories. Any item of an unusual nature should be separately explained.

Table A data

If at all practical, reference should be made in table A to each of the following categories of research activity:

1. The number of separate projects (that is, organized projects as distinguished from subdivisions and individual experiments);

2. Funds obligated for the most recent fiscal year (fiscal year 1959 for U.S. agencies);

3. Number of scientific man-years devoted to the activity in the most recent fiscal year. (A scientific man-year is defined for this purpose as the full-time assignment of a research employee who has the B.S. degree, its equivalent or better, and who is directly engaged in or is directly supervising the activity, as distinguished from a technician whose work is entirely under the direction of a scientist);

4. Approximate number of supporting man-years of effort for the most recent fiscal year, insofar as such information may be available (i.e. "Supporting" effort may include technical, diener, secretarial, and administrative man-years directly related to the project).

Data to be described and to be keyed into table B

Information on who, where, when, why and relationships is explained immediately below. These paragraphs should be specifically keyed into the table on "Organizational data", as indicated below.

Who? That is, what division in the organization is sponsoring the research, to whom does it report, and what is its part in the total organization?

Where? What would be a brief, general description of the physical facilities devoted to the research, in terms, possibly of location; unique characteristics, if any of the laboratory facilities, special equipment, personnel, etc.? Where the research is carried on through contracts with a number of universities or institutes, it will be sufficient to state simply that the work is done in so many university or institute laboratories. Where the research is done in only a few such laboratories, these should be identified together with any special features about them.

When? Is the program conducted on a regular basis, or on an irregular or ad hoc basis? In either case, when was it begun, and are there plans for altering, increasing or terminating the direction of the effort?

Why? What is the significance of the effort in the overall mission of the supporting agency or organization in terms of its own statutory requirements?

With what relationships to other organizations? It is desired to set forth the relationships of each agency's research efforts to the efforts of other agencies and organizations, to note how the various efforts may complement and supplement one another, how gross duplications are avoided, and how the research results are disseminated and made available to policymaking authorities. Brief summary information is desired on interagency relationships and intergroup working committees, with special emphasis on worldwide organizations and interrelationships. How, for example, does research information developed in one place find its way into worldwide application (through other than standard reporting in scientific journals etc.)?

The two basic tables which agencies are requested to fill in

There follows an outline of the two tables, A and B, which represent the basic way through which agencies are asked to cooperate with the subcommittee.

TABLE A.—BUDGETARY AND MANPOWER DATA

Research category	Number of projects	1959 fiscal year (obligated)		
		Funds	Scientific man-years	Supporting man-years
1. Biology				
2. Genetics				
Etc				

TABLE B.—ORGANIZATIONAL DATA

Research category	Special comment on research categories	Who	Where	When	Why	Relationships
Radiation biology	P. 2, a	P. 6, f	P. 4k, l, m	P. 7, p	P. 8, r, s	P. 9
Radiation genetics	P. 3, b	P. 8, g	P. 5, k, o	P. 7, p	P. 8, s	P. —
	P. 3, c	P. 9, h	P. 6, n	P. 7, p, q	P. 8, r	P. —

"P. 2, a, b, c" etc., is a sample reference to descriptive paragraphs which elaborate on the "who", "where", etc. headings requested above.

Unique features, if any, of one or more of the nine categories of research if different from the description in appendix A.

PART 4. ROLES OF INTERGOVERNMENTAL ORGANIZATIONS

This part will contain a brief summary to be obtained through the Department of State on the work of intergovernmental groups, in connection with organized radiation research.

Liaison officers in each of these organizations will be invited to cooperate with the subcommittee in compiling brief summaries, pertinent to the main interest of the committee print—namely, on who is doing what, where, when, why, how and with what relationship.

The subcommittee does not wish to pose an excessive burden on the State Department or on the supranational organizations in responding to this need. But the subcommittee anticipates receiving such data as may prove comparatively readily available and has already received gracious messages of cooperation.

The organizations include:

United Nations:
First United Nations International Conference on the Peaceful Uses of Atomic Energy.
Second International Conference on the Peaceful Uses of Atomic Energy.
International Atomic Energy Agency.
World Health Organization.
International Labor Organization.
Office for European Economic Cooperation.
Euratom.
United Nations Education, Scientific and Cultural Organization.
World Meteorological Organization.
Others.

PART 5. INDIVIDUAL NATIONS' INTERNATIONAL ACTIVITIES AS REGARDS BIOMEDICAL RESEARCH IN RADIATION

This part will contain brief summaries of organized research work in certain individual countries. Here again, through Department of State, the appropriate offices abroad will be invited to cooperate with brief pertinent summaries.

The countries include:
United Kingdom.
France.
Union of Soviet Socialist Republics.
Others.

PART 6. RADIATION RESEARCH ROLE OF COMMERCIAL INDUSTRY AND AGRICULTURE

PART 7. RADIATION RESEARCH ROLE OF INTERNATIONAL PROFESSIONAL ORGANIZATIONS AND JOURNALS

Contents of parts 6 and 7 will be abstracted from a considerable volume of replies already received by the subcommittee. These replies have come from a broad gamut of companies and organizations which have previously been contacted in connection with all types of biomedical research.

PART 8. CONCLUSIONS

APPENDIX A

NINE RESEARCH CATEGORIES

1. *Radiation biology.*—Studies on somatic effects of exposure to radiation from sources external to the organism or other target material; normal physiological processes and responses where these must be studied further to provide background information for understanding the perturbations caused by radiation; developmental aberrations; psychological and performance effects. Molecular and cellular systems, tissues, organs and whole organisms are included in this category.

2. *Radiation genetics.*—Studies of the effects of radiation on the genetic constitution of single cells, plants, animals and human beings; gene mutations and mutation rates; chromosome aberrations, population genetics; chemistry of genetic units as it relates to the genetic process. Experiments designed primarily to im-

prove crops or livestock should not be included in this category, but under "Agriculture."

3. *Environmental radiation.*—Studies of the environmental situation including background radiation, meteorology, oceanography and marine sciences; ecological and epidemiological responses to the environment; demographic and public health statistics; fallout and environmental contamination, but excluding studies made primarily to facilitate weapons testing.

4. *Toxicology.*—Studies of the metabolism and toxic effects of radioisotopes (both natural and manmade) to which man and animals are exposed.

5. *Radiation protection.*—Studies of procedures for combating radiation effects, including biological and medical treatments; waste management, shielding against radiation, health physics methods; pure physics which is conducted for its ultimate application to problems of radiation control.

6. *Agriculture.*—Studies on agriculture insofar as crops and farm animals may be improved by the use of isotopes or radiation, or as they must cope with increasing radiation in the environment; plant and animal physiology as related to radiobiological studies.

7. *Medical applications.*—Studies on the genesis and diagnosis of cancer and leukemia, insofar as these studies utilize radioisotopes and radiation; diagnosis and treatment of disease with radioisotopes and teletherapy.

8. *Radiation detection and measurement.*—Studies on the development of instruments and methods for the detection and measurement of radiation and radioisotopes, including whole-body counters and bioassay procedures.

9. *Education, training, and information.*—Programs devoted specifically to increasing technical competence and public knowledge in the area of radiation effects in the life sciences.

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[1] The Subject Index which follows is the work of William E. Bost and Hugh E. Voress of the Office of Technical Information Extension, Atomic Energy Commission, Oak Ridge, Tenn. The subcommittee is pleased to acknowledge its appreciation.

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